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ABSTRACT

An instructional manual for reference use in college and university teaching is presented, based on a 2-year study of the specific difficulties that students have in receptive communication (listening and reading) in introductory courses. Although the investigation focused primarily on the disciplines of psychology, physics, and philosophy, many of the instructional techniques are applicable in other disciplines. Seven types of difficulties in reading and listening were hypothesized for students in introductory courses, and a model for investigating students' problems was followed. Receptive language problems of introductory psychology, physics, and philosophy students included: technical and general vocabulary, explanations of key principles, metaphors, specialized language style factors, and complex sentence structures. For each of the three disciplines, examples of difficulties in these areas are provided. In addition, for each discipline, 20-24 instructional techniques are discussed in terms of purpose, learning principle, time required for use, preparation, and teaching suggestions, and illustrations are included. Suggestions for use in other disciplines, a bibliography, information on receptive language problems in English general writing, and a language difficulty data form are also included. (SW)

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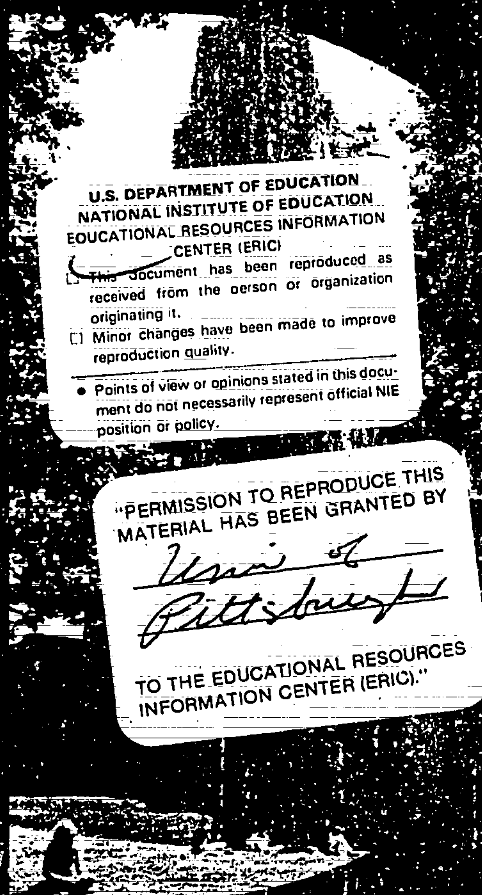

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UNIVERSITY OF PITTSBURGH

TEACHING TECHNIQUES for the LANGUAGES OF THE DISCIPLINES

An Instructional Manual
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DISTRIBUTION

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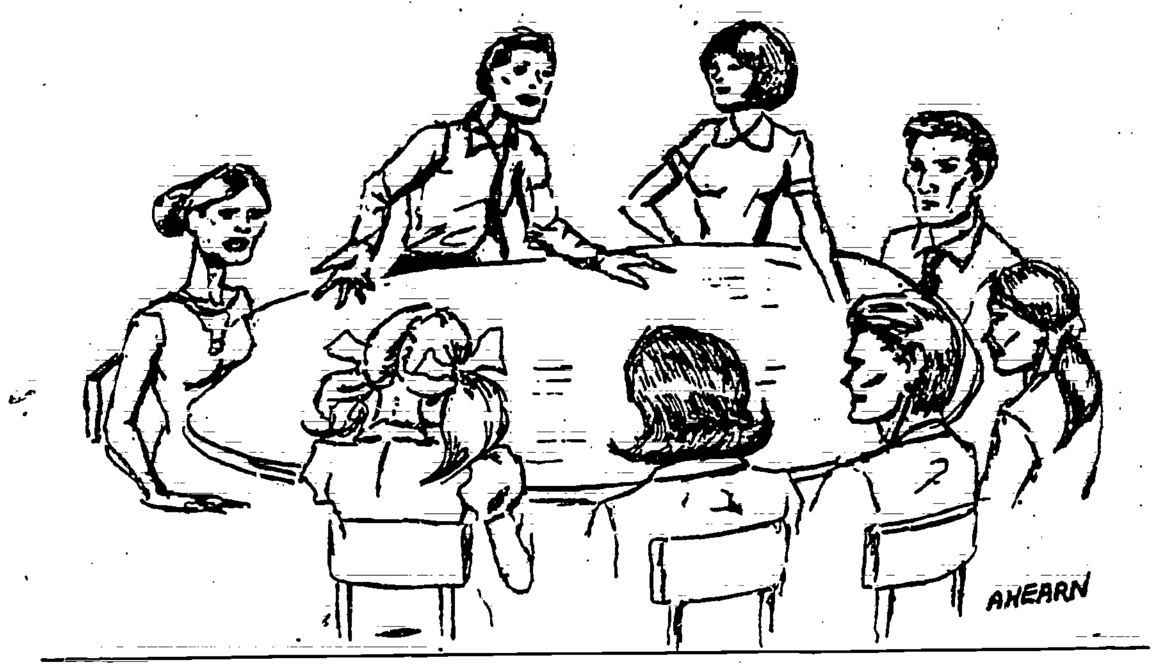


Chapter I

RECEPTIVE LANGUAGE PROBLEMS OF COLLEGE STUDENTS

This instructional manual for reference use in college and university teaching is the result of a two-year investigation into the specific types of difficulties that students have in receptive communication (listening and reading) in introductory courses in the college disciplines. Although the investigation focused primarily on three disciplines -- psychology, physics, and philosophy -- with temporary attention to English composition, many of the instructional techniques included here are equally applicable in other disciplines. (See Chapter IX for suggestions.)

After one year of itemizing students' problems through class observations and small group discussions, the project team began to gather instructional techniques and devices to prevent or to overcome those difficulties, while also continuing to note problems. ("Techniques" are instructional procedures, while "devices" are aids, such as transparencies, charts, and models, which supplement instruction; in general discussion both are referred to as techniques.) Ideas for techniques were sought from the cooperating professors teaching the courses, from references, and from colleagues. Many were formulated by adapting procedures used by members of the team in teaching other courses in college or at lower levels.

All techniques, of course, are related to observed student problems. Within the one-year of the second phase of the project it was possible to develop more than three score techniques, but these obviously are not enough to offset all of the hundreds of difficulties that students and language study group leaders noted.

Types of Difficulties in Reading and Listening

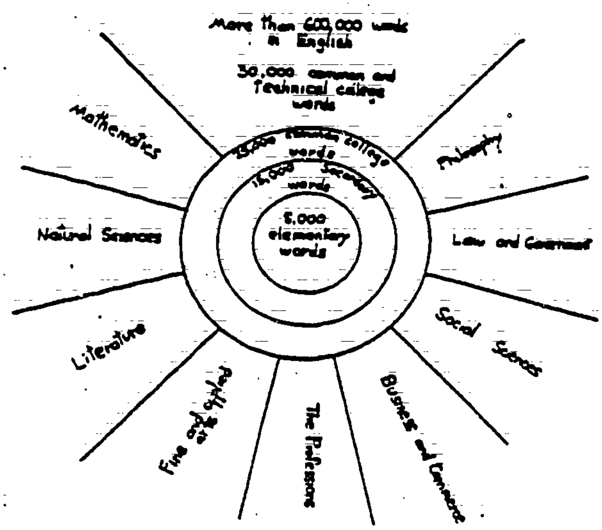
Based on their observations when teaching introductory college courses in other fields and on suggestions made by the project advisory committee, the project team hypothesized that students in introductory courses would have difficulties in the seven areas of receptive communications explained here.

1. Technical Vocabulary of the Discipline. Every discipline uses terms that are quite unique to that field. In economics, for example, a student must be able to differentiate between "partial equilibrium" and "general equilibrium." Much of the content of introductory courses, in fact, centers on technical terms and their underlying concepts. Students seem to have special problems with words for which they know meanings in other contexts that are different from the meanings in the discipline being studied.

2. Advanced General Vocabulary. Frequently professors will use advanced general vocabulary, such as "strategy," "deduction," or "disingenuous," in their lectures. When these terms are new to undergraduate students, the students often confuse them with technical vocabulary.

3. Explanations of Key Principles, Theories, Generalizations, and Complex Concepts. Beyond word and phrase vocabulary items, each discipline has a set of key principles, theories, generalizations, and complex concepts that serve as the assumptions on which assertions in the field are based. A few of these in each field constitute the foundation for other essential understandings. In linguistics, for example, one universal belief is that a living language changes constantly. Likewise, the artist believes that different impressions of balance, perspective, texture, and rhythm can be achieved in design through variations in the use of line, space, and color. When students do not fully understand explanations of principles, they seem merely to memorize them instead of conceptualizing.

4. Metaphorical Expressions Used in the Discipline. Metaphor, or figurative speech, is used constantly in everyday communication--so constantly, in fact, that it becomes so familiar that it is difficult to differentiate it from the "standard" forms of speech. (Example: "The car is running." So where did it get legs with which to run?) Each discipline has metaphorical expressions that are an extension of its vocabulary. When a sociologist speaks of the "lifeboat ethic," he conveys an idea quite different from that conveyed by the two words used separately. In addition to discipline-specific metaphor, there are general metaphors that also are used often in various disciplines.



5. Specialized Language Styles Used in the Discipline. Difficulties with specialized language styles are not caused primarily by the technical terminology, although technical terms may be used in such expressions. Instead the specialized styles consist of uncommon syntactic structures that are specific to a discipline in the same way that some metaphorical expressions are specific to a discipline. A couple of examples that have been used in various fields are given here:

   Example from statistics: This difference is significant at the .01 level.
   In ordinary language: This difference could have occurred by chance only once in a hundred times.

   Example from law: The defendant did with intent to inflict grievous bodily harm cause the gun to be discharged against the victim.
   In ordinary language: The defendant shot the victim intentionally.

6. Complex Sentence Structures. Some complex sentences are unusually long and involved, although they may contain no unusual discipline-unique expressions. In most cases, such sentences include several dependent or independent clauses that make it difficult to differentiate between the main point(s) and the supporting details contained in the sentence or the passage.

7. Unusual Graphic, Tabular, or Symbolic Materials. A sizeable part of some textbook chapters is comprised of complex diagrammatic, graphic, or tabular materials. Another common problem encountered by students is the learning of specialized symbols or formulas used in courses such as philosophy, mathematics, or statistics. Students may be confused by forms with which they are not thoroughly familiar.

Difficulites Noted During the First Year

Data on student difficulties were gathered through monitoring introductory courses and having small groups of students keep logs of the problems they encountered. Each of the language study leaders (who during the first year were advanced graduate student language specialists) was asked to attend the classes in one field regularly and to meet for an hour a week with approximately fifteen volunteer student participants from each class. Each leader was assigned to audit the course in which he or she had the least background in order to get some idea of the problems a beginner in the field might experience. Every week the undergraduate student volunteers were provided with log sheets on which to record the specific words, phrases, sentences, symbols, etc., that gave them difficulty in the lectures or in the reading.

The procedures for data collection can be summarized as follows:

--Language study leaders attended the content course classes regularly, taking notes, and observing student behavior.

--Students listed and classified their difficulties on the log sheets and later noted the correct meanings that they found for the points on which they were unclear.

--Student groups met for one hour weekly with the language study leaders to discuss their difficulties and attempt to improve their understandings of the subject content by sharing their interpretations and by responding to questions and comments of the leaders.

--Language study leaders collected the log sheets regularly and recorded on cards the different communication comprehension difficulties of the students.

--Language study leaders consulted the course textbooks and conferred with the course instructors and assistants to obtain greater understanding of the students' difficulties.

These procedures were followed for the two regular trimesters of the first year, with different cooperating professors teaching the courses each trimester.

During the second trimester the study group leaders made a special effort to differentiate among items that were merely new, that were real difficulties, and that were serious difficulties. Items that merely were new, but not truly difficult for the diligent student were eliminated from the lists. Items that twenty-percent or more of a group found to be difficult, and which could not be easily understood from a readily available source were considered to be serious difficulties. All others were listed simply as difficulties.

The total numbers of problems (TP) noted by students and group leaders during the first year are itemized in the Table 1, with additional columns to indicate how many of the total problems were classified as serious problems (SP).

Table 1

Receptive Language Difficulties Encountered in Introductory College Courses during the First Year

	Philosophy		Physics		Psychology	
	TP	SP	TP	SP	TP	SP
- Technical Vocabulary	38	25	153	26	112	56
- General Vocabulary	18	8	37	0	39	0
- Explanations of Principles, Theories, Generalizations	10	7	21	7	57	6
- Metaphors in the Discipline	4	1	8	0	3	3
- Specialized Language Style Factors of the Discipline	1	1	3	0	3	3
- Complex Sentence Structures	0	0	3	0	2	2
- Tabular, Graphic, Symbolic Materials	0	0	1	0	1	0

These findings were used to initiate the collection and development of techniques and devices for preventing students' reading and listening problems. This development was emphasized during the summer trimester.

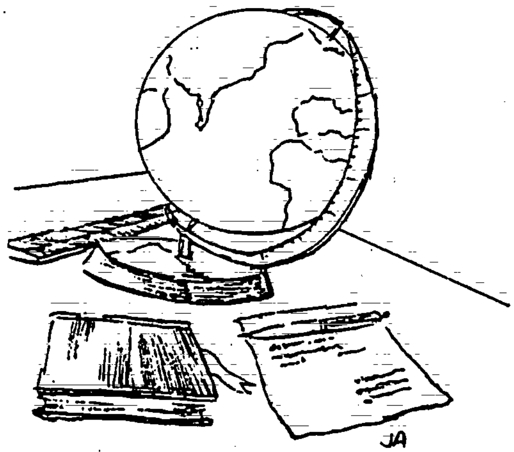
Difficulties Cumulated over Two Years

During the first trimester of the second year the collection of data on receptive communication difficulties continued with new classes. At the same time the language study group leaders were trying out some of the instructional techniques to determine whether they were effective in helping students in small groups overcome such problems. During the following trimester the data collection continued through informal observations, which instructional techniques were being used with whole classes in physics and philosophy and with a larger number of small groups in psychology.

The project team members assumed that most difficulties would have been noted during the two regular trimesters of the first year and, therefore, that the lists of items would not increase much, if any, as a result of the data collection during the second year. This assumption proved to be wrong. Instead, there was a tendency for the numbers of receptive communications problems to increase, particularly in psychology. It is possible to explain these increases rather easily, however.

In every one of the three disciplines there was a different instructor teaching the introductory course druing every trimester. Apparently this arrangement is common so that instructors also have opportunities to teach favorite advanced courses regularly. In some cases this change of instructors meant, also, a change in the basic textbook, plus a major change in the lecture emphasis. This change in emphasis was not as apparent in physics, where the fundamental principles are fairly standard, as it was in psychology, where the range of coverage is very broad and susceptible to variations in attention. Here it was noted that a professor naturally might use more of the vocabularly and the concepts from the area in which he was doing research than from other areas. For example, a professor doing research in the psychology of language might use more of the technical terms and related ideas from that area than from other areas, while still giving the others their full share of coverage.

An obvious factor affecting differences in philosophy difficulties was the selection of a different type of course for observation during one semester than during others. During the trimesters of the first year an introductory course in logic was the focus for investigation, because that was the introductory philosophy course for which the largest number of students was enrolled. The project team and some members of the philosophy faculty, however, decided that this provided a rather limited view of the types of receptive communication problems that students might have in that discipline. Therefore, during the fall trimester of the second year the investigation was conducted with a different



introductory course that dealt with the ideas of some of the great philosophers of the world.

Another factor in the increased length of some lists of difficulties was the change every trimester in the membership of the small language study groups. Although there was a tendency for the major difficulties to be noted by members of more than one group, it was inevitable that the students in additional groups would come up with a few more items of difficulty. Team leaders noticed, also that some indificuals in a group would mention having difficulty with a certain concept or explanation only after somebody else in the group mentioned it; this caused inconsistencies among groups.

Some lists of difficulties may have grown slightly shorter than they were previously. This is because the team studied the lists carefully and decided that certain items should be classified differently than they originally were, or in a few cases they eliminated items entirely because it was evident that a conscientious student could find an easy explanation in a source that was readily available.

The numbers of total problems (TP), including serious problems (SP), that were cumulated in the lists of difficulties by the end of the second year are shown in Table 2.

Table 2

Receptive Language Difficulties Encountered in Introductory College Courses during Two Years

	Philosophy		Physics		Psychology		English Comp.
	TP	SP	TP	SP	TP	SP	TP
Technical Vocabulary	77	37	148	54	299	79	88
General Vocabulary	36	10	43	13	58	9	74
Explanations of Principles, Theories, Generalizations	42	30	29	7	72	12	51
Metaphors in the Discipline	3	3	13	3	14	2	22
Specialized Language Style Factors of the Discipline	5	5	3	0	7	1	2
Complex Sentence Structures	5	5	2	0	10	4	0
Tabular, Graphic, Symbolic Materials	0	0	3	0	4	1	3

The students at the University of Pittsburgh usually have ranked among the top forty percent of their high school graduating classes. Data on the students who voluteered to participate in the language study sessions revealed that they were generally representative of the whole student body. Therefore students in colleges that have admission standards different from those at Pitt should expect that their students will have more or less difficulties than the numbers listed above.

Some Observations about Students Problems

The information in Tables 1 and 2, plus the project team's notes on students in action make possible these observations concerning students' reading and listening difficulties in introductory college courses:

1. The type of course content obviously makes a difference in the numbers of difficulties that students have. (But something else is not shown in the tables; that is that in some cases many more students may have the same difficulties rather than many students having different difficulties. Therefore the numbers of different difficulties do not necessarily indicate the differences in overall course difficulty.)

2. Technical vocabulary, as might be expected, is by far the largest type of difficulty that students have in introductory courses.

3. General vocabulary is another major type of problem, because every learner's vocabulary must continue to expand, especially that of a relative novice in a technical discipline.

4. Problems related to explanations of key principles, theories, and generalizations are not nearly so numerous as those related to vocabulary, but they are very serious. This is true because a student who fails to understand even a very few key principles may find it impossible to comprehend other essential ideas in a discipline.

5. While difficulties with metaphors and specialized language style factors should not be overlooked, they are much less numerous than the vocabulary and theory comprehension factors in introductory courses. A careful examination of the textbooks suggests that authors have made the introductory texts relatively simple and have left the more specialized discipline-specific language structures for inclusion in more advanced courses.

6. Sentence structures of unusual complexity, likewise, are relatively uncommon in most introductory course texts. There are, however, exceptions to the texts that are written for "easy" reading.

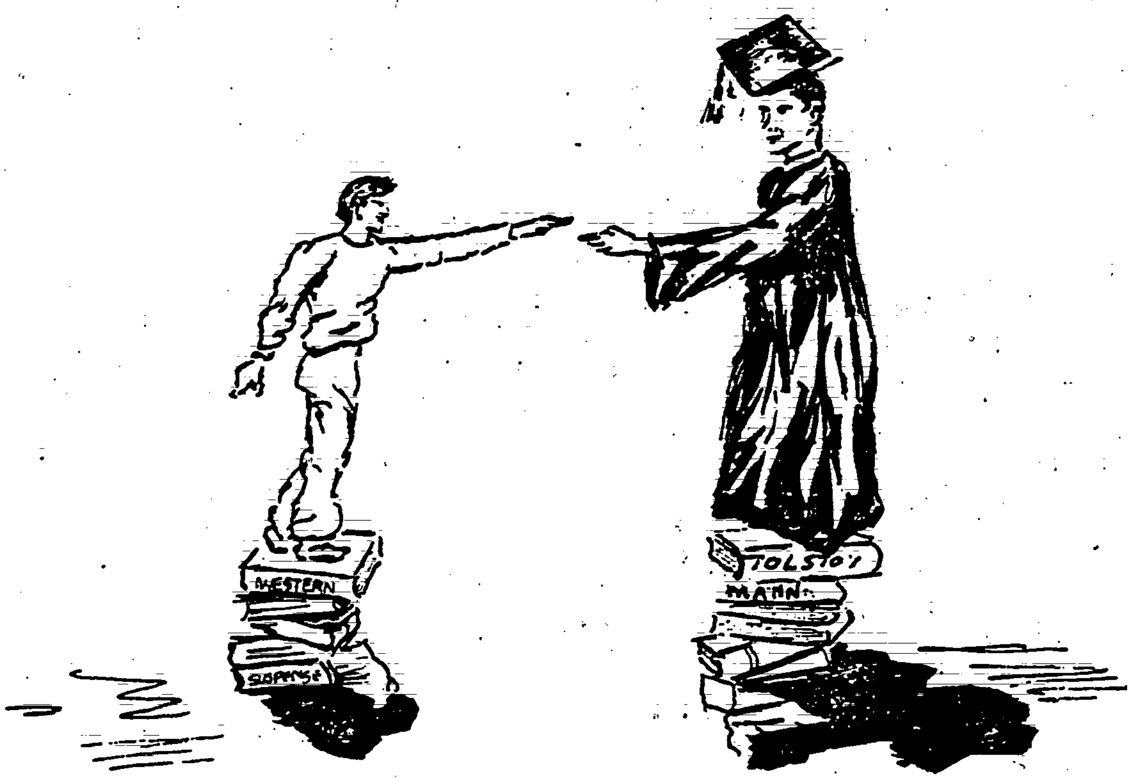
7. One special problem in vocabulary is the multiple meanings of words. When a student knows a common meaning for a word and then learns a new meaning of a technical nature, he seems to have difficulty in remembering the new meaning. There is a tendency for the older meaning to interfere over time with his memory of the new.

8. When some students do not fully understand an explanation for a principle, theory, or concept, they tend to memorize a definition or explanation instead of pursuing the idea until they can conceptualize it. This has been observed in other studies, also. (Champagne, Klopfer, Anderson, 1979).

9. Because they are bombarded with information that is new to them, many college students in introductory courses tend to be satisfied with a partial understandings of a new concept, theory, or principle, but they readily agree that their understanding has increased when reinforcing experiences are provided.

10. If the disciplines studied here are typical of all the disciplines, college instructors can expect that the serious reading and listening difficulties of thir students will be distributed approximately this way: 62% in technical vocabulary, 12% in general vocabulary, 18% in explanations of key principles and generalizations, 3% in metaphors related to the discipline, 2% in language style factors specific to the discipline, 3% in sentence complexity, and less than one per cent in tabular, graphic, and symbolic factors. These proporations will vary somewhat from field to field, of course. If, for example, this computation had been based on total problems instead of serious problems, the English course information would have been included. The proportion of difficulties in metaphor would have been increased considerably.

Lists of the difficulties tabulated for the three major disciplines being studied can be found in Chapters 3, 5, and 7 of this manual.



Chapter 2

A MODEL FOR INVESTIGATING STUDENTS' PROBLEMS

The findings about students' receptive language problems that are presented in the instructional manual were gleaned through the application of an investigative model that is described here. The model is introduced with an explanation of the reasons for its development.

The Communication Gap

Growth in technology during the twentieth century has drastically changed the employment patterns of the nation's workers. While the majority of Americans at one time worked in agriculture, now less than four percent of them are able to fill our agricultural needs and provide vast quantities of food for export. During this century great numbers of farm workers moved to the cities to take blue-collar jobs, but today only a few more than thirty percent of Americans are employed in blue-collar labor. The majority of people now work in vocations and professions that require specialized skills and training. Consequently there is an ever-growing need for well-educated persons to operate the industries and services of the country.

At a time when the nation needs a smaller proportion of minimally educated persons and a larger number of health workers, engineers, social problem solvers, and creative thinkers, our colleges and universities are finding it difficult to convince more students of the need for higher education. And they find it equally difficult to help and encourage some of the potentially capable individuals to remain in college after they have begun. One reason for this is the knowledge gap.

The often-mentioned explosion of knowledge apparently started a chain reaction which has provided a constant flow of information that is essential for successful study in the university of disciplines. At the same time, however, it appears that the problems of social unrest and of limited financial support for the public schools have created a major gap between what some high school graduates have learned and what they need to know in order to succeed in beginning courses in colleges and universities. Therefore about one-fourth of the students who are admitted to higher education drop out in the first year and nearly another fourth drop out or transfer before graduation.

There are many reasons why students have difficulty and become discouraged in their introductory college and university studies. One of the major reasons, according to faculty members who have taught college reading skills courses, is inadequately developed receptive communication skills. For quite a number of students there is a great gap between their levels of capability in obtaining information through reading and listening and the level of skill that is required for success in courses. Faculty members from a number of fields of study have noted this type of communication gap. (Sartain, Bond, Nossen, Stahl, Haynes, & Stein, 1982)

Even persons who are highly educated in one field often find that they do not readily comprehend discussions among people who are specialized in another field. Each discipline seems to have not only its specialized vocabulary, but, also, its own style for organizing statements. This is most evident when any layman tries to follow the jargon of an attorney. Therefore it is not at all surprising that many high school graduates may become very discouraged when trying to follow the ideas in professors' lectures and in college textbooks.

The project on The Languages of the Disciplines was conceived, therefore, to investigate and try to correct the receptive communication difficulties of students taking courses in various academic fields. Supported financially by the Fund for the Improvement of Postsecondary Education of the United States Department of Education and by the University of Pittsburgh, the project also had strong backing from the

Provost's Office and the University Research Center. Faculty members from the Psychology Department (CAS) and from Language Communications (Education) were given time to coordinate the project, and others from Philosophy, Physics, and Psychology gave generously of their time and knowledge.

The Investigative Model

The initiation of the project required the development and later revision of a set of procedural steps for identifying the receptive communication problems of students and for supporting professors in overcoming those difficulties. This sequence of steps can serve as a model for other schools wishing to investigate and correct the receptive communication problems of their own students.

As the model evolved, these were the major steps taken: (1) Establishing informal hypotheses, (2) Selecting experimental students and faculty, (3) Gathering data through student language study sessions, (4) Refining data and procedures through faculty involvement, (5) Seeking solutions to communications problems, (6) Testing and refining tentative solutions, and (7) Sharing the results. These steps will be explained in more detail.

Establishing Informal Hypotheses

Two informal hypotheses were developed; some portions being stated before the project was initiated and other portions being added as their importance became apparent. They were:

1. Receptive communication factors that interfere with the learning of some students in introductory university courses can be identified; among them the following may be found:

    a. Verbal explanations of key principles and abstract generalizations
    b. Technical vocabulary of the disciplines
    c. Advanced general vocabulary
    d. Metaphorical expressions specific to different disciplines
    e. Specialized styles of language used in different disciplines
    f. Complex syntactic structures used in some textbooks and references
    g. Language-related devices such as symbols, graphs, and tables

2. Special types of lessons and instructional devices can be located or devised and used by faculty members and their assistants in overcoming these problems.

These informal hypotheses were stated to guide the program development more than to serve as the basis for rigorous controlled research. They have led, however, to the collection of a large amount of useful data on student problems and instructional techniques.

<u>Selecting Experimental Students and Faculty</u>

Because of the impossibility of investigating problems in all of the disciplines at once, a decision was made to begin with three unrelated fields of study. The fall term class schedule was consulted to find courses that enrolled large numbers of students, and an introductory course in each of three broad areas was selected: a philosophy course in the humanities, a physics course in the physical sciences, and a psychology course in the social sciences. In the second year an English course was added to the program for one trimester.

Thereafter the selection steps were:

--Conferring with professors teaching sections of the courses to obtain cooperation from those who would be regular participants in the data collection and program development.

--Seeking volunteer participants from the class members at the first class session (Students were offered one extra credit in language study for the work.)

--Selecting for each course approximately fifteen participants from the volunteers by randomly choosing the needed number from those available at necessary times.

Gathering Data through Language Study Sessions

This Process is explained on pages 4-7 in Chapter 1.

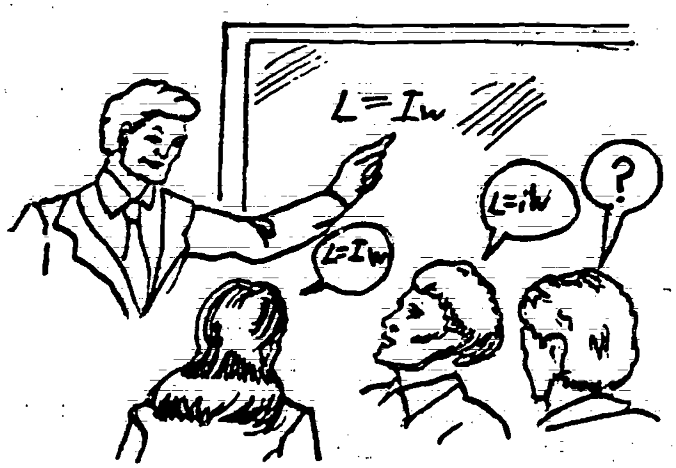
Refining Data and Procedures through Faculty Involvement

Faculty members were involved in a variety of ways, some continuously and some occasionally.

--The cooperating professors conferred regularly with the language study group leaders, noting the difficulties recorded by the students and adding others that might be anticipated. They also made suggestions on how such difficulties could be overcome.

--A number of additional professors and teaching assistants from each of the three disciplines and related areas met individually or in groups with project personnel to react to the lists of difficulties noted by the study group leaders, to consider why students had such difficulties, and to offer ideas for preventing the difficulties in the future.

--An advisory committee of faculty members and administrators met from time to time with the project directors, the project coordinator, and the group leaders to review plans and findings and to advise how to proceed in future activities.



Seeking Solutions

During the second trimester of the first year of the investigation the project staff began seeking instructional techniques and devices for overcoming the difficulties experienced by students. During the third trimester (summer) the whole task of the team was to identify such solutions and to prepare a manual of suggestions for future use by professors and teaching assistants. These efforts to seek solutions included the following steps:

--Faculty members who taught the courses and their colleagues, as mentioned previously, were a major source of ideas for techniques to overcome students' problems.

--Professional textbooks on teaching strategies, on college training, and on secondary and college reading were reviewed to provide a reservoir of ideas that could be referred to by the language study group leaders.

--Study group leaders began preparing devices, such as transparencies with overlays, comprehension structure charts, logical thinking guides, and concept demonstration gadgets, which were reviewed at meetings with the project directors and analyzed for their effectiveness in teaching.

--Journals and reference books in each field of instruction were skimmed at the university library to find the best pedagogical ideas of writers in those areas.

--The group succeeded in describing more than sixty techniques and devices for teaching specific terms, principles, metaphors, special language structures, and symbolic systems that had been particularly difficult for the students to understand in introductory courses. Most of these are described in Chapters 4, 6, and 8.

Student Difficulties: The Findings

During the fall trimester of the first year the students in the language study groups noted more than four hundred terms, explanations of principles, and other language factors that caused them difficulty in the three introductory courses in philosophy, physics, and psychology. During the second trimester the language study groups leaders, working with different groups of students, assessed these "difficulties" carefully to differentiate between those that were real problems and those that were quite easily overcome through study and discussion. They also continued to itemize other difficulties listed by the new classes.

Nobody was surprised that vocabulary was a major problem. A few examples of the many technical terms that cause difficulties for students were: "syllogism," "premiss," "adiabatic process," "angular momentum," "centripetal acceleration," "chunking," and "intervention." Some of the general vocabulary items that were unfamiliar to many students were: "electic," "pragmatic," "conjecture," "vacuous," and "contingent."

Metaphorical expressions might be considered to be simply another aspect of specialized vocabulary, so they often are difficult to distinguish. Some that caused problems for a number of students were "depositing charge," "decision tree," and another "tree" with "branches" that function in semantic tableaux. In connection with both the metaphorical expressions and the technical vocabulary, students had problems understanding and remembering the specialized technical meanings of words that have other every-day meanings. Examples include: "work," "power," "mass," and "conservation."

Instructors noted that many students have a tendency simply to memorize explanations of principles and complex generalizations without fully understanding them. A few of the items for which they had difficulty comprehending the explanations were: the work-energy theorem, Bernoulli's Principle, Maxwell's distribution of speeds, and validity of an argument. Two specific examples of universal truths that were difficult to comprehend were: (1) "The validity of an argument is determined by the truth values of its premisses and its conculsion;" and (2) "A compound is truth-functional when its truth value can be determined under all possible circumstances by the truth values of the components."

Problems of special language style are difficult to separate from general explanations unless the observer readily recognizes unique language structures. This is not easy when one is reading in a field that is new to him or her. And the person who is highly trained in a field does not sense that certain language forms are strange to others.

Problems of specialized language style were encountered in philosophy in statements that begin with, "It is not the case that . . ." Likewise there was a problem in psychology with reading "removed in time and space" in such statements as "Language permits displacement, the transmission of information about objects or events that are removed in time or space (or both) from the communicator . . ."

The difficulties with language complexity were not numerous for most groups at Pitt. They seem to cause more problems for students having reading competence below the average.

Second Year Difficulties

During the first trimester of the second year the investigation continued with new classes, different professors, and in some cases, different textbooks. While the same introductory courses were studied in physics and psychology, an introductory course on ideas of great philosophers was substituted for the introductory logic course that was monitored during the two trimesters of the first year. In addition to recording and discussing reading and listening problems, the language study group leaders began to try out the instructional techniques and devices that they had begun preparing during the previous spring and summer.

During the second trimester of the second year as many as possible of the instructional techniques were tried out in full-sized classes in physics and philosophy (logic this time), while multiple small group trials were arranged in psychology to make certain comparisons possible. The itemizing of difficulties continued in psychology.

The exact reading and listening difficulties located in each discipline are listed in Chapters 3, 5, and 7.

Overcoming The Problems

As mentioned earlier, the recommendations for preventing or overcoming the receptive communications difficulties of students in introductory university courses include both special lesson techniques and specific instructional devices. Often these can be used together, but they also can be used separately at times.

A number of types of lessons and devices are listed here, and many that were suggested or devised are explained in Chapters 4, 6, and 8.

Lesson Techniques

Procedures listed as lesson techniques are those that involve some sequence of interaction and thinking leading to a desired understanding without any unusual instructional materials. In using the paired comparisons technique, for example, the instructor has the students compare terms, two at a time, to determine whether one term is subordinate, equivalent, or superordinate to the other; thereby the students sharpen their understandings of the concepts that are labelled by those terms.

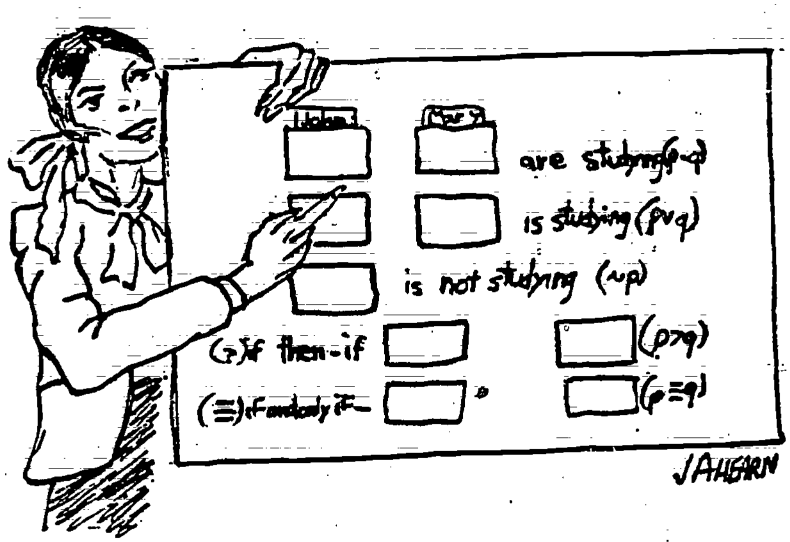
The following lesson techniques were considered, and many were found to be suitable for the disciplines involved in this project. Some, however, might be more useful in other disciplines.

- inductive concept formation procedure (Taba)
- inductive application of principles process (Taba)
- advance organizers (Ausubel)
- concept attainment procedure (Bruner)
- inquiry training
- synectics procedures
- contingency management
- field trips
- programmed lessons
- simulation experiences
- learning dyad or triad process
- demonstration lessons
- semantic mapping
- root webb procedure
- text reading guide
- guided inquiry
- project lesson
- syntax transformation process
- structured induction lesson
- directed reading activity
- SQ3R study system
- underscoring procedures
- self-recitation
- pretesting
- QUEST

- topic sentence perception
- summarizing
- memory model process
- Socratic questioning sequence
- reverse reasoning process for rule comprehension
- etymological analysis
- visual contrast approach to conceptualization
- role playing
- paired comparisons
- illustrated question sequence

Some of these lesson techniques were gleaned from references such as those by Joyce and Weil (1980), Singer and Donlan (1980), and Devine (1981). Others were originated by the team members or by the course instructors.

As mentioned previously, cooperating teachers have said that one of the major difficulties many students have is a failure to conceptualize from their listenting or reading. That is, they tend to memorize without truly understanding, and then they fail in trying to provide applications for rules and principles. The reverse reasoning process for rule comprehension is an example of a lesson technique designed to overcome this problem. Here the instructor offers a rule that the students can do this successfully, the instructor can be quite sure that they really understand the rule instead of having merely memorized it.



Instructional Devices

Words are the coins of communication, but as with all currency, their value fluctuates. When students are constantly bombarded by words, they have difficulty sensing their full worth. Consequently language must be given extra life from time to time with visual aids that command attention and increase the clarity of the intended communication.

Many instructional devices have been used by teachers for centuries, but new ones are constantly needed for novelty and to help students cope with the increased complexity of the content of the university disciplines. The following are among those recommended in this situation. Again, some came from references and others were originated by the project team:

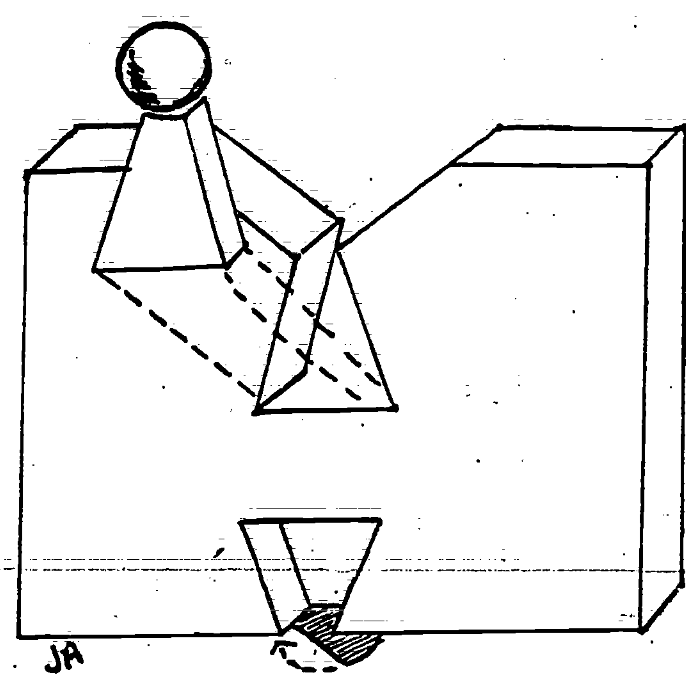
- continuum cards
- sorting box guides
- hierarchy charts
- marginal glosses
- transparencies
- transparencies with overlays
- semantic hierarchy diagrams
- general diagrams
- manipulative models
- drill games
- mock-ups
- charts and maps
- flash-cards
- graphs of several types
- formulas
- pictures
- simulation strips or boxes
- sequence folders
- wheel matchers
- dioramas
- critical attribute lists
- visual contrast devices
- structured overview designs
- pie-chart models
- demonstrative cartoons
- population sample cards
- structured summary block designs
- contrast charts
- cartooned illustrations

The instructional devices tend to be specific objects or materials that are used, not as a whole lesson, but as a part of a lesson to build interest and understanding. The structured overview design, for example, is a diagram of cue-boxes and lines that provide the student with a bird's-eye view of a topic that is to be studied. The student fits the subtopics into the boxes to obtain an understanding of the relationships of the elements included in total topic.

A second example is a set of inductive learning flash-cards. In one case, to explain incidental learning the students are told to obtain a certain type of information as the cards are flashed; then they are asked to answer questions about other information that they could have learned incidentally from the same cards.

A set of population sample cards is a third example of an instructional device. Varying measures of a certain human characteristic, such as height, are noted on a large number of cards. Then samples of "people" can be drawn from the cards to illustrate normal distributions or, perhaps, significant differences between averages.

Obviously new times and new circumstances call for the development and utilization of new procedures for encouraging students to complete programs of higher education. The project on Languages of the Disciplines was an attempt to develop new techniques and to revitalize old ones in order to help a larger proportion of students succeed. Faculties wishing to adopt these processes or variations of them are invited to utilize the investigative model to institute their own program development plans. They also are offered the information on student problems and the instructional techniques described in the following chapters.



Testing and Refining Suggested Solutions

During the second year, as mentioned previously, a major part of the project was to try out the instructional materials that had been devised, to revise them, and to extend them for future use. This involved:

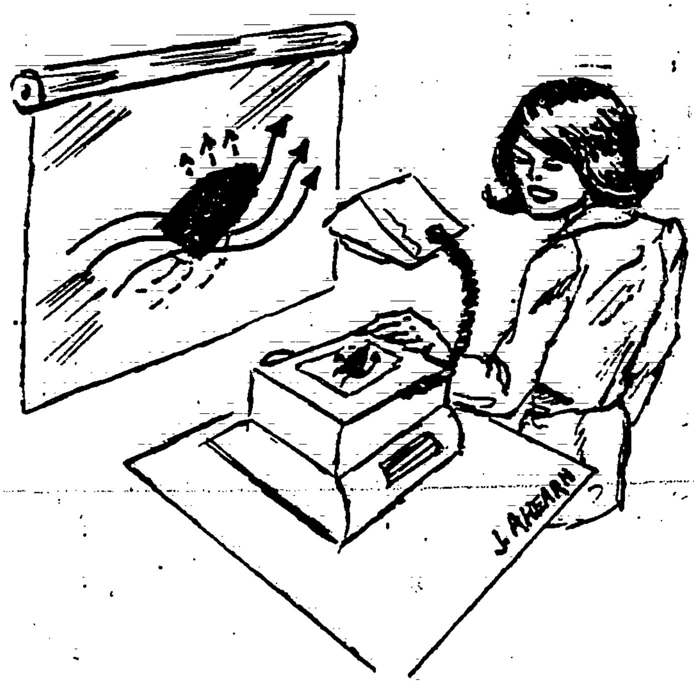
--Trying out the special lessons and devices in the new language study sessions for each descipline (or in the "recitation" sections, which are small group supplements to the regular lecture classes).

--Revising the materials on the basis of their effectiveness.

--Adding new lesson techniquew and devices.

--Providing revised descriptions of instructional aids for trial use by the course professors during the second trimester of the second year; and determining the effectiveness of the materials in the manual.

--Obtaining student evaluations of as many techniques and devices as possible on the form shown on the following page.



Summary of Student Evaluations

Name of Technique ____________ Number of Evaluations ____________
Subject Area ____________ Date of Evaluation ____________
Instructor ____________

1. Did you list this as a problem in your log? ______#Yes ______#No ______%Yes ______%No

	Not at All 1	2	Somewhat 3	4	Very Much 5	Average Rating
2. To what degree was this problem a difficulty for you?						
3. To what extent did the technique/device attract and hold your interest?						
4. To what extent did the technique/device resolve your problem?						
	Do Not Recommend 1	2	Recommend 3	4	Strongly Recommend 5	
5. Would you recommend that this technique/device be used in a lecture?						
6. Would you recommend that this technique/device be used in a recitation section?						
7. Would you recommend the use of this technique/device to teach this Language component?						
8. What are your suggestions to improve this technique/device?						

(List the comments provided by the student on side two of this sheet.)

Sharing Results

The results, including both the information on types of difficulties that students have and the instructional materials for use in overcoming problems, were shared within the University of Pittsburgh and outside the University as far as the information could be disseminated.

This process included:

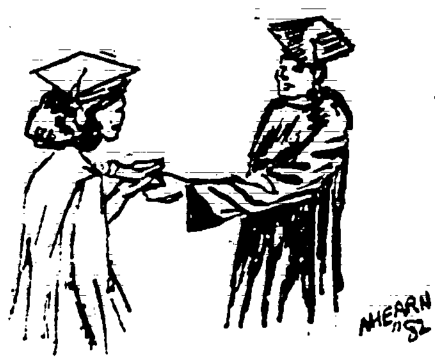
--Sharing the dindings and the instructional aids manual with other professors in the disciplines involved at Pitt.

--Providing orientation workshops for college and high school faculties in Pennsylvania, Ohio, and West Virginia who were interested in learning the results and the process involved.

--Presenting the findings and the process steps at professional meetings both regionally and nationally.

--Informing other departments at Pitt of the investigation while using a questionnaire to obtain information from them about student difficulties in their disciplines.

This sharing process is being continued by the dissemination of detailed information on student difficulties and instructional procedures in the following chapters. Although some of the evaluative findings are not complete at the time of this writing, general information on student and faculty responses is provided wherever possible.



Chapter 3

RECEPTIVE LANGUAGE PROBLEMS

P S Y C H O L O G Y

The numbers of reading and listening difficulties encountered by experimental groups from introductory psychology classes during four trimesters from Fall of 1980 through Spring of 1982 were as follows:

	Total Problems	Serious Problems
Technical Vocabulary	299	79
General Vocabulary	58	9
Explanations of Principles and Generalizations	72	12
Metaphors in the Discipline	14	2
Specialized Language Style Factors of the Discipline	7	1
Complex Sentence Structures	10	4
Tabular and Graphic Presentations	4	1

Any item that students mentioned as a difficulty was considered to be a problem, but an effort was made not to avoid including items merely because they were new to the students. An item was considered to be a serious problem if it was classed as a difficulty by twenty percent or more of any group and if it could not be easily understood or answered by referring to the text or to another readily available source. Since most of the students at the University of Pittsburgh are from the upper forty percent of their high school classes, more problems might be listed as serious in colleges that admit a larger proportion of high school graduates. Surely one could expect more problems with sentence complexity among less competent students. Likewise, a smaller proportion of difficulties would be serious in a more selective school.

As might be anticipated, the largest number of difficulties was with technical vocabulary. Although the number of serious difficulties in explanations of principles and generalizations was not great, failure to understand even a few such key items could result in very poor achievement for the student. It appears that metaphors and special language style factors may be used less frequently in introductory courses than is likely in more advanced courses.

The problems encountered in the experimental groups from the four classes in psychology are itemized below. The classification of an item as technical vocabulary, general vocabulary, metaphor, etc., had to be based on somewhat subjective judgements, so other educators may prefer to classify some items differently. Those problems that seemed to be serious are starred.

* ablation
absolute threshold
* accomodation
accuity
adrenacine
* aerial perspective
afferent nerves
after images
altered state of consciousness
* ambiguous stimulus
amygdala
annuism
* anterograde amnesia
aphasia
approach avoidance
* assimilation
ataxia
attention span
* attribution
automatic writing
* autonomic nervous system
* axon
behaviorist
biased sample
binocular cue
* binocular disparity
* blind spot
brain lesion
* catharsis
central core
cerebellum
cerebral hemispheres
chaining
* chunking
clustering
coding
* cognition
cognitive detectors
cognitive learning
* concept
* concrete operation
conditioned response
conditioned stimulus
* confabulation
conservation (cognitive)
consolidation
construct validity
content validity
contralateral control
control group
convergent thinkers
corpus callosum
* correlation coefficient
cortex
cue
cue verdical
death instincts
defense mechanism
deja vue
dendrites
dependent variable
depth perception
descriptive statistics
developmental psychology
dichotic listening
difference threshold
diffusion of responsibility
* discrimination learning
discrimination stimuli
* displacement
* dissociation
dissociative neurosis
divergent thinkers
dorsal
double blind experiment
Down's Syndrome
echoic
effective motivation
* eidetic imagery
embryonic period
empiricist
encoding
* endocrine system
erogenous zones
* E.S.P. (extrasensory perception)
evoked potentials
excitatory state
expediential effects
extinction
face validity
factor analysis
feature analysis
feature detectors
fixation
fixed interval
fixed ratio
* flow fields
form equivalence
* formal operational
* fovea

free association
Galvanic skin response
* Gaglion cell
generalization gradient
germinal period
gestalts
glia
habituation
* hemispheric lateralizations
heterogeneous chains
* heuristic
hippocampus
homeostasis
homogenous chains
* hypothalmus
iconic mode
imprinting
incidental learning
* independent variable
inflection
inhibition
insight
instrumental conditioning
* internalization
intrapersonal standards
intuitive phase
involuntary response
* kinesthesis
latent learning
libido
life instincts
* limbic system
linear perspective
localization of functions
* long term memory
media bias
median
medulla
* meiosis
memory retrieval
memory storage
memory trace
* metacognition
method of loci
* mixture suppression
* mnemonic devices
* modality specific
* monocular cues
morpheme
morphology
* motion parallax
motivated forgetting
motor cells

multiple control
multiple personality
myosis
nativist
* negative feedback
negative punishment
* negative reinforcement
nervous system
* neuron
neuropsychologist
neurosis
neutron
nodes of Ranvier
norepinephrine
object concept
object permanence
observational learning
olfactory epithelium
operant conditioning
optic chiasma
optical illusions
overt behavior
* paradigm
parallax
* parasympathetic nerves
parasympathetic system
partial reinforcement schedule
peneal body
* perception
perception of movement
* perceptual constancy
perceptual set
perfect correlation
peripheral nervous system
* phi phenomena
phobia
* phoneme
phrenology
pluralistic ignorances
pons
positive reinforcement
precocial
predictive validity
preoperational stage
presocial species
primary neural aging
primary reinforcement
proactive interference
psychophysics
psycholinguistics
punishment
radical behaviorism
random sample

receptive field
receptor cells
recoding
* redintegration
reductionistic
reflex
reflex arc
* regression (toward the mean)
reification
REM
representational thought
representative sample
respondent behavior
* reticular activating system
reticular formation
retinal detachment
retinal disparity
* retroactive inhibition
* retroactive interference
* retrograde amnesia
rhodopsin
* rods
sample
saving score
schedule of reinforcement
* schema
scheme
secondary reinforcement
selective attention
semanticity
semantic network
senescence
* sensitive period
* sensory gating
sensory motor stage
septal area
serial recall
serial scanning
shadowing
* shaping
* short term memory
skewed distribution
socialization
somatic
somatic division (of the peripheral nervous system)
somato sensory cortex
spontaneous behavior
* standard deviation
state dependent behavior
* statistically significant
* statistics
stimulation
stimulus control
* stimulus generalization
stimulus substitution
storage
stroboscopic motion
structuralism
subjective contours
sublimation
* superposition
swimming reflex
sympathetic
* sympathetic nervous system
synapse
synaptic space
synaptic vesicles
* syntactic
synthesia
tactile
* target organs of endocrine system
template matching
terminal
* texture gradient
thalmus
Thematic Aptitude Tests (TAT)
threshold
trace dependent
* transduction
transfer of training
transmitter substances
unconditioned response
unconditioned stimulus
validity
* variable
* variable interval
* variable ratio
ventral
verbatim recall
* veridical
vestibular sense
* visual capture (or dominance)
visual illusion

* algorithm
assiduously
audition
auditory
compliance
compulsion
* cones
conformity
contiguity
contingency
contingent
continuity
convergence
convoluted
* deductive reasoning
desensitization
elicit
* equipotentiality
generalization
grope
hierarchical
identification
identity
illusion
* inductive reasoning
inferiority
inferred
inhibitory
intensity
nuances
* obfuscate
* pandemonium
phonetics
placebo
precarious
premise
propositions (language)
proximity
recall
redundancy
reincarnation
* replication
repository
repression
retrieval
reverberatory
salient focal colors
scanning
scope
semantics
* shibboleth
similarity
subordinate
superiority
superstitious behavior
survey
utility
variable ratio

EXPLANATIONS OF KEY PRINCIPLES, THEORIES, GENERALIZATIONS, AND COMPLEX CONCEPTS IN PSYCHOLOGY: THE DIFFICULTIES NOTED

Sometimes the students reported only the phrase with which they had difficulty instead of the whole statement. In many cases the phrase has been amplified here by the statement from one of the textbooks; but usually in cases where the phrase was taken from a lecture, no expansion has been possible. In some instances it is possible that a professor misspoke or that several students misunderstood what was said. When both a lecture statement and a textbook statement was mentioned, the textbook statement is given here. Although the students considered each item to be a "key" principle, theory, or generalization, a person having more background might well consider some to be relatively minor matters. Items found to be serious problems are starred.

1. activation theory--"Some psychologists believe that intensity is the sole characteristic of emotion, that the level of arousal is the only thing that makes it possible to tell one emotion from another. This activation theory holds that all behavior lies along a continuum of activity, from the low level of sleep to high excitement." (Morris 1979, pp. 388).

2. altered state of consciousness--"...the cognitive and intellectual controls on behavior can be weakened by sensory overload, altered states of consciousness, and a reliance upon noncognitive feedback (such as physical absorption in the act)." (Zimbardo 1980, pp. 508)

3. approach/avoidance--"The tendency to approach a desired goal gets stronger the nearer the subject is to it. The tendency to go away from a feared place or object also gets stronger the nearer the subject is to it." (Zimbardo 1980, pp. 314).

4. Bell-Magendie Law--"The relationship--'dorsal equals sensory' and 'ventral equals motor'--was one of the first consistent functional features of the nervous system to be discovered. It is named the Bell-Magendie law..." (Braun and Linder 1979, pp. 251-252).

*5. biofeedback process--"Individuals can be taught to control a variety of internal body processes by a technique known as biological feedback, or biofeedback. In biofeedback, small changes occurring in the body or brain are detected, amplified, and displayed to the person and/or researcher. Sophisticated recording and computer techniques make it possible for a person to attend to subtle changes in heart rate, blood pressure, temperature, and brain-wave patterns..." (Zimbardo 1980, pp. 374).

6. blame-the victim/psychology

7. brain regulates behavior--The brain regulates behavior in three major ways. "The task of determining exactly how the brain controls behavior is obviously a very difficult one." (Wortman and Loftus 1981, pp. 99)

8. brain wave functioning--"When the graph shows that the yogi's brain is emitting a steady flow of slow rhythmic alpha waves, the experiment begins...His brain, deep in meditation, registers no reaction to these disturbances..."(Wortman and Loftus 1981, pp. 386-387).

9. classical conditioning process--"repeated pairing of a neutral stimulus with a stimulus that evokes a reflex response until the previously neutral stimulus alone evokes the response." (Wortman and Loftus 1981, pp. 614)

10. cognitive development perspective--"...many psychologists view cognitive development as a series of qualitatively different stages. At each progressive stage, they argue, the child's characteristic ways of thinking about and approaching the world become more mature...Not all psychologists agree with a stage approach to cognitive development, however. Some believe that many of the qualitative differences in cognitive ability that seem to exist between an older and a younger child may be largely explained by quantitative differences in the knowledge that the two have acquired..." (Wortman and Loftus 1981, pp. 245)

*11. cognitive functioning--"The cognitive function, as an ultimate mode or aspect of the conscious life, is contrasted with the affective and conative--feeling and willing--or it is noesis as contrasted with orexis." (Drever and Wallerstein 1964, pp. 42)

12. cognitive school--"They broaden the domain of psychological reality beyond limits of behavioral reactions to external stimuli. Mental processes--attending, thinking, remembering, planning, expecting, wishing, fantasizing, and consciousness itself--are 'stuff' of the cognitive psychologists. In counterpoint to the physical actions emphasized by the behaviorists is the uniquely human activity of self-awareness." (Zimbardo 1980, pp.24)

13. cognitive theory of learning--"...cognitive psychologists argue that what a rat acquires when it learns to run a maze is not necessarily a series of automatic movements controlled by specific stimuli, but rather a 'cognitive map' of the maze's spatial layout..cognitive psychologists maintain that much of human learning takes place without overt rewards or punishments being meted out. Two types of learning that fall into this category are latent learning and social learning through observation..." (Wortman and Loftus 1981, pp. 169-170)

14. Collins andQuillan Theory--"A monent's reflection will reveal that your world is very neatly structured through hierarchies of concepts..." (Wortman and Loftus 1981, pp. 211)

*15. concept network development

16. conservation process--The preschool child "believes that number can vary with an irrelevant transformation, such as a change in spacing...Two other conservation problems beyond the grasp of the preschooler, conservation of mass and conservation of length...Conservation of number is usually understood first at around age six or seven, then conservation of liquid, still later conservation of weight...although older children grasp a growing number of specific concrete operations, they cannot yet understand the similarities among them." (Wortman and Loftus 1981, pp. 250)

17. consolidation hypothesis--It is assumed that a "reverberatory" process or a series of solidifying events occurs in the brain when memory is attained.

18. Constitutional differences theory--William Sheldon's constitutional differences theory of personality "created obvious associations between body size and type with activities and preferences. Endomorphs are relaxed, love to eat, sociable, gut-oriented. Mesomorphs are physical people filled with energy, courage, and assertive tendencies. The ectomorphs are brainy, artistic, introverted temperaments who think about life rather than consuming it or acting upon it..." (Zimbardo 1980, pp. 299)

19. contiguity law--Contiguity is "a necessary, but not sufficient, condition to account for learning associations." (Zimbardo 1980, Glossary III)

20. criterion for abnormal behavior--"The decision to declare someone to be insane or mentally ill is always a judgment about behavior. We have seen throughout our study of psychology that the meaning of behavior is jointly determined by its content and the context in which it occurs. The same act in a different setting conveys very different meanings..." (Zimbardo 1980, pp. 388)

21. criterion-referenced/norm-referenced test development--Published achievement tests usually are norm-referenced, because their standard scores are based on norms, while criterion-referenced tests are developed to reflect mastery of a particular body of content.

22. effect, the law of--"A theory formulated by Thorndike that S-R connections are strengthened by satisfying events and weakened by unsatisfying or unsuccessful ones." (Zimbardo 1980, Glossary IX)

23. Erikson's theory of personality development--"Erikson identified eight stages of psychosocial development describing the human cycle of life from infancy through old age. At each stage a particular conflict comes into focus. Although it is never resolved once and for all, it must be resolved sufficiently so that the individual can cope successfully with the conflicts of later stages..." (Zimbardo 1980, pp. 134)

24. escape and avoidance conditioning--"There are three aversive control paradigms: escape, avoidance, and punishment. In escape and avoidance conditioning behavior that effectively terminates the aversive stimulation is strengthened and maintained..." (Zimbardo 1980, pp. 75)

25. fragile short-term mechanism problem--"Like sensory-information storage, short-term memory has limited capacity and can only store a small amount of information, about five to seven unrelated items, whether words, letters, numbers, or something else...Further, if short-term memory is overloaded, information will be pushed out." (Zimbardo 1980, pp. 136)

26. forgetting attributed to "decay" and "interference"--"Perhaps the oldest theory of forgetting is that memories simply fade away, or decay, with the passage of time if they are not renewed through periodic use...The concept of decay...may be useful in explaining loss from fragile short-term memory, but its application to long-term memory is open to question...The phenomenon of interference is another reason for forgetting. According to this view, memory of a year-old movie fades due to the unavoidable confusion that results when people subsequently encounter very similar experiences..." (Wortman and Loftus 1981, pp. 202)

27. focusing strategy--"...Through more and more experience with other examples of arthropods you would gradually learn to eliminate from your definition all those features that can be varied and still yield an instance of the concept. This approach to concept formation is called a focusing strategy because you begin with a composite hypothesis and gradually focus in on the relevant characteristics." (Wortman and Loftus 1981, pp. 212)

28. Gall's Theory--"Gall suggested that the human brain was composed of thirty-seven distinct organs, each of which was related to a fundamental behavioral 'trait' and that the size of an organ reflected the magnitude of the corresponding trait." (Braun and Linder 1979, pp. 246)

29. general adaptation syndrome--"According to Selye (1956), the general adaptation syndrome involves three stages: alarm, resistance, and exhaustion. The alarm stage begins with activation of the sympathetic nervous system. The organism is made ready for action: Glucose level rises, heartbeat and breathing accelerate, in short the body pulses with energy... If stress continues, the body soon responds with what Selye calls resistance..." (Wortman and Loftus 1981, pp. 326)

30. generalization, principle of--"...In generalization, a range of stimulus values similar to the originally conditioned stimulus will elicit the response. And a range of response values similar to the originally reinforced one are enacted and reinforced..." (Zimbardo 1980, pp. 75)

31. Gestalt psychology--"According to Gestalt psychologists, we are constantly organizing bits and pieces of information into meaningful patterns. These patterns are called gestalts, after the German word for 'pattern' or 'whole'... The Gestalt is said to be greater than the sum of its parts...From their data they formulated a number of principles to explain how sensory stimuli are structured so as to lead to the perception of gestalts. Two of the major concepts they came up with are grouping and figure-ground..." (Braun and Linder 1979, pp. 29)

32. hypothesis testing theory--"Hypothesis testing is a strategy that is commonly used by scientists to solve problems. It involves the formulation and testing of ideas about the manner in which a goal can be reached...As we generate each of these possible solutions, we test it in our mind or in reality ...We continue to develop and test hypotheses about how to solve our problem until an acceptable solution is reached." (Braun and Linder 1979, pp. 130)

33. inferential statistics functions--"Often the goal of research is to explore hypotheses, and for this purpose psychologists must turn to what are called inferential statistics. Inferential statistics provide ground rules or conventions for determining what conclusions can legitimately be drawn from data. ...Researchers...must make use of inferential statistics to infer (draw a reasonable conclusion as to) whether the data clearly support the original hypothesis..." (Wortman and Loftus 1981, pp. 55)

34. interference theory--As new information gets mixed up with other information, it becomes harder to remember.

*35. linguistic competence vs. linguistic performance--"Linguistic competence is a person's intuitive grasp of the rule for constructing grammatical sentences. But there is obviously much more to human language than implicit knowledge of structural rules alone...The application of our implicit knowledge of grammar during speaking or listening is known as linguistic performance." (Wortman and Loftus 1981, pp. 279)

*36. linguistic relativity hypothesis-- "...According to his linguistic relativity hypothesis, thinking is patterned by language, and the language one speaks determines one's view of the world. If a language lacks a particular expression, according to Whorf, the thought that the expression corresponds to will probably not occur to the people speaking that language." (Morris 1979, pp. 221)

37. linguistic universals--"Interest has shifted to...the extent to which thought influences language, rather than language thought...Are there universal characteristics of human thought processes that create universal linguistic structures?" (Braun and Linder 1979, pp. 214)

*38. Maslow's Hierarchy--"...Maslow deliberately set out to create what he called a 'third force' in psychology, one that offers a strong alternative to psychoanalysis and behaviorism... what he called the hierarchy of needs...Maslow believed that all humans face a series of needs in life, and that needs at the lower levels must be met before the person can go on to fulfill those at the next higher level...fundamental needs ...psychological needs...need for self-actualization..." (Wortman and Loftus 1981, pp. 430-431)

39. memory, theory of--"Many theorists now separate memory into three distinct levels: the sensory register, short-term memory, and long-term memory...They regard these levels as stages in a kind of refining system through which raw materials pass. At each level, the material is reworked and is either discarded or stored." (Morris 1979, pp. 188)

40. mind-body question--"...what is the relationship between mind and body? There is no doubt that relationship is a complex one...Today, although psychologists continue to speak of the mind and the body as separate entities for convenience of discussion, most acknowledge that mind and body are intimately entwined. But...no one knows exactly how..." (Braun and Linder 1979, pp. 6-7)

*41. moral development--"According to Freud, as the child identifies with parents and takes on their standards, the conscience develops...Some psychologists describe moral development in terms of stages...Piaget has identified various stages in children's awareness and use of moral rules...A similar stage theory has been proposed by Kohlberg...each level is seen as requiring a more advanced level of cognitive development... preconventional level...conventional level...postconventional level..." (Morris 1979, pp. 113-114)

42. multiple control principle--"...the performance of any specific behavior is likely to involve most or all of the brain. The complementary principle also seems to be true: that is, a specific part of the brain is likely to be involved in the performance of many types of behavior. This is called the principle of multiple control." (Braun and Linder 1979, pp. 264)

43. nativist theory--According to the nativist theory children acquire language largely through natural development rather than through learning.

44. neodissociation view--relates to a loss of interrelationships between groups of mental or semantic processes as with schizophrenics.

45. objective permanence--To an infant objects have no existence other than their own interaction with them. According to Piaget, a very young infant does not seem to understand that her body is one object in a world of objects, some animate like herself and others inanimate.

46. Oedipus conflict--"According to Freud, gender role identification and the adoption of sex-typed behaviors are the result of the Oedipus conflict, which presumably occurs between the ages of three and five or six. This is the time when most children discover the genital differences between the sexes, and this discovery, according to Freudian theory prompts children to see themselves as rivals of their same-gender parent for the affection of the parent of the opposite sex. Freud believes that a great deal of anxiety develops as a result of these desires. . ." (Wortman and Loftus 1981, pp. 262)

47. opponent process model--"Beginning with the assumption that organisms are designed to maintain a certain biological and psychological balance, Solomon and Corbit argue that when a strong emotional response disrupts this balance an 'opponent process' is activated. . . If the initial emotional response is negative, the opponent process will be positive, and vice versa. . ." (Wortman and Loftus 1981, pp. 362)

48. optimum level of arousal theory--"According to Hebb, motivated behavior begins with the occurrence of some appropriate sensory event. . . These sensory inputs then travel to appropriate regions of the cortex, where they serve to direct behavior. Simultaneously, the same sensory signals activate the reticular formation, which bombards the cortex with diffuse neural impulses. If this diffuse cortical arousal is within a certain range, appropriate goal-directed behaviors will result. Thus there is an optimal level of arousal for effective behavior. . ." (Wortman and Loftus 1981, pp. 359)

* 49. optimum solution

50. overlearning vs. cramming--Overlearning is "learning in which repetition or practice has proceeded beyond the point necessary for the retention of recall required..." (Drever and Wallerstein 1952, pp. 198) Cramming is "a method of preparing for an examination by memorizing the material immediately before the examination, mainly by repetitive methods, and relying on recency and frequency for success in reproducing the material." (Wortman and Loftus 1981, pp. 55)

51. overregularization of speech forms--"One reason the acquisition of grammar is so difficult is that there are exceptions to many grammatical rules. Consequently, young children tend to commit errors of overregularization--that is, they overextend a grammatical rule to instances in which it should not apply..." (Wortman and Loftus 1981, pp. 295)

*52. paradigm for respondent conditioning--"A paradigm is a symbolic model or diagram that helps us understand the essential features of a process...Paradigms are ways of thinking about a certain class of events or processes that affect those events ...The central idea of the respondent conditioning paradigm is: the learned association between a weak and a strong signal transfers sufficient power to the weaker stimulus so that it comes to elicit the same response(s) originally controlled only by the stronger one..." (Zimbardo 1980, pp. 41)

*53. personality development theory variations--"Psychoanalytic approaches emphasize childhood experiences as critically important in shaping adult personality...behavioristic and social learning approaches are those based mainly on principles of learning and reinforcement...Trait theories say simply that human behavior can be organized according to characteristics that are called traits...Finally, phenomenological approaches emphasize the potential of human beings for growth, creativity, and spontaneity..." (Wortman and Loftus 1981, pp. 40)

54. Piaget's stages of development--According to Piaget the stages of child developmentare:(1) the sensory-motor stage, (2) the preoperational stage, (3) the concrete operations stage, and (4) the formal operations stage.

55. psychobiology investigations--"investigation of psychological problems in the field of general biology" (Drever and Wallerstein 1952, pp. 230)

56. psychoanalytic theory--"...Freud encouraged them to talk directly about their difficulties, and from this he developed his psychoanalytic technique of 'free association of ideas.' He found that as patients mentioned their thoughts and described their dreams, they began to remember thoughts or events that they had forgotten. Once these events were remembered, the patients could deal with them successfully..." (Morris 1979, pp. 422-423)

57. psychodynamic behavior theory--"The psychodynamic view of psychopathology, like the biomedical one, locates the core of the disturbance inside the disturbed person. It accepts a general model of a disease core that shows up in symptoms. However, it emphasizes ongoing, intense psychological processes rather than physical imbalances...neurosis is viewed as the inability to resolve adequately the inner conflicts between the unconscious, irrational impulses of the id and the internalized social constraints imposed by the superego..." (Zimbardo 1980, pp. 424)

58. psychosis, characteristics of--"Psychoses are severe disturbances characterized by disordered thought, inappropriate emotions, and bizarre behavior. The psychotic is out of touch with reality, living in a private world and behaving in ways other people find difficult or impossible to understand..." (Morris 1979, pp. 520)

59. pure research vs. applied research--Pure research is done for its own sake. Out of pure research comes applied research which focuses on a specific problem.

60. quantitative growth--Differences in the knowledge that children acquired at different stages appear to be qualitative differences in cognitive ability.

*61. schema development--"The process of assimilating new information and experiences involves organizing past reactions and experiences into cognitive structures called schemas." (Zimbardo 1980, pp. 128)

62. self theory of Carl Rogers--"As we mature in our infant years, Rogers believes, we gradually acquire awareness of being and awareness of functioning. A portion of our private world then becomes differentiated to us as 'me' and becomes our conscious self...At the same time, we form value judgements and become aware of pleasurable and unpleasurable experiences." (Morris 1979, pp. 435)

*63. serial position curve--"The results of a series of experiments ...that elegantly demonstrate the separate contributions of short-term memory and long-term memory to the serial position curve. The black dots show the percentage of correct recalls as a function of the position of the word in the list. The colored line in A represents the idealized form of the data..." (Braun and Linder 1979, pp. 112)

64. sex roles, development of--"Despite common assumptions about the 'natural' and 'biological' differences between the sexes, most research on the subject does not support the notion of profound differences...Children are socialized into stereotyped sex roles through pressure at home (such as the use of sex-typed toys and clothing) and through sex stereotyping in the schools and the mass media." (Morris 1979, pp. 106)

65. social learning theory--"In the social learning view, behavior, personal factors, and environmental factors all operate as interlocking determinants of each other. It is true that behavior is influenced by the environment, but the environment is partly of our own making. Behavior is shaped by reinforcers, but it is usually human beings who make those reinforcers available or scarce for one another." (Zimbardo 1980, pp. 81)

66. S-R associationist school--"...views the learning process as the development of associations between stimuli and responses..." (Braun and Linder 1979, pp. 75)

67. trace decay theory--The passing of time causes the strength of memory traces to decrease, making memory more difficult.

68. trait theory--"Trait theories (of personality) say simply that human behavior can be organized according to characteristics that are called traits--for example, aggression, friendliness, and honesty. People differ from one another in the extent to which they exhibit particular traits..." (Wortman and Loftus 1981, pp. 406)

69. transfer from STM to LTM--"It is generally believed that the transfer depends on the amount of time the information has remained in the rehearsal cycle: the longer the time, the more likely the transfer. Once information begins to enter long-term storage, still more time is needed for consolidation processes to firmly fix it there. According to this consolidation theory, unless the initial physiological change, or memory trace, caused by the new information has time to become stable and firm, new information coming in may interfere with or obliterate it. The longer the consolidation processes operate, the more durable the memory..." (Braun and Linder 1979, pp. 110)

70. visual depth/distance cues--"Depth perception is simply the ability to tell how far away an object is...depth perception is partly the result of the fact that the brain receives visual input from two eyes rather than one...There are a number of monocular cues...that augment depth perception...motion parallax...relative size...linear perspective...texture gradient ...partial overlap..." (Wortman and Loftus 1981, pp. 130-131)

71. Weber's Law--"...according to Weber's law, the amount of a stimulus needed to produce a just noticeable difference is always a constant proportion of the intensity of the stimulus..." (Braun and Linder 1979, pp. 271)

72. Yerkes-Dodson Law--"At low levels of motivation arousal performance is poor; as motivation increases, performance improves, but only up to a point. After a certain point, called the optimal arousal level, further increases in motivation cause performance to deteriorate. This relationship ...is often called the Yerkes-Dodson law..." (Braun and Linder 1979, pp. 137)

METAPHORS USED IN PSYCHOLOGY: THE DIFFICULTIES NOTED

1. All this I lap up with avidity; no one has ever dished me up more praise than I can swallow.

2. Behavior involves, in effect, finding the buttons another person has and pressing them in such a way as to get others to respond as you wish.

3. This is an example of the cocktail party phenomenon.

4. The eye is like a camera.

5. The behavior was preceded by the firing of a neuron.

6. The researcher could not see the forest for the trees.

7. His research was placed in a holding pattern until additional funds were available.

*8. Long-term memory is similar to a library with its card catalog, or to a book and its index.

*9. Memory is a good press.

10. Memory is like a written paper.

11. Memory traces can be compared to paths in the woods.

12. The level of memory called the sensory register by cognitive psychologists is like a reception room for the other memory functions.

13. The thalmus is a sort of switchboard or relay station for messages received by the brain.

14. "Just a decade earlier physicists . . . had succeeded in tapping the secrets of nuclear fission." (Wortman and Loftus 1981, pp. 149)

SPECIALIZED LANGUAGE STYLE FACTORS IN PSYCHOLOGY: THE DIFFICULTIES NOTED

*1. They planned the experiment according to a within-and-between subject design.

2. Children have difficulty comprehending a situation that is removed in time.

3. Older children recognize that something exists even if it is removed in space, while very young children do not.

4. Rules of phonology identify the particular sounds that are linguistically meaningful and prescribe how they should be ordered to form words.

5. The ability of an individual to organize and process visual information, as in finding a simple figure in a complex one, is a characteristic of perceptual development.

6. Both the fixed internal and the fixed ratio schedules of reinforcement are based on regular and predictable relationships between behavior and reinforcement.

7. Operant behavior followed by an aversive stimulus results in punishment.

COMPLEX SENTENCE STRUCTURES IN PSYCHOLOGY: THE DIFFICULTIES NOTED

*1. When action potentials reach the end of the axon, chemicals called transmitter substances stored in sacs at the top of the axon are released into the synapse, a tiny gap that separates an axon from a connecting neuron, transmitting a message to the neurons.

2. Psychologists sometimes use participant observations, in which members of a research team actually join an existing group in order to record end impressions that are accessible only to group members.

*3. Epileptics who had undergone certain kinds of brain surgery obtained relief from their epilepsy, but they sometimes suffered an unfortunate side effect: they could no longer transfer information from short-term to long-term memory; that is, they could no longer learn from and retain new experiences.

4. Hearst and Jenkins pointed out that the outcome of both kinds of learning is the same: in both cases, the time sequence is: stimulus — response — reinforcement.

5. In classical conditioning, the sequence involves a conditioned stimulus which produces a conditioned response and is followed by a reinforcer, still getting a response in each repetition, but with responses obtained in two different ways; in the end is always the reinforcement.

*6. This concept will become increasingly apparent throughout this book: The emphasis on learning underlies contemporary approaches to such psychological processes as motivation, perception, and thinking, and learning theories form the basis for much of the practice of education and rehabilitation today.

*7. Although negative reinforcement and punishment are two completely different processes, they are often categorized, as here, under aversive conditioning, because they both involve aversive stimulation.

8. Some indirect evidence is provided by the fact that any event that either suppresses neural activity (such as a blow to the head, carbon monoxide poisoning, or heavy anesthesia), or causes neurons to fire incoherently (such as electroconvulsive shock) can apparently 'erase' information held in short-term memory.

9. Most important for an understanding of motivation, this general state of cortical arousal seems essential for sensory signals otherwise reaching the cortex to activate a goal-directed response.

10. For one thing, if a reader is shown a passage printed so that each line contains a separate constituent, he or she will comprehend the passage better than if the lines break mid-constituent.

TABULAR, GRAPHIC, AND FORMULA PRESENTATIONS IN PSYCHOLOGY: THE DIFFICULTIES NOTED

1. A graphic presentation of the spectrum of electromagnetic energy. Description: "The small portion of this spectrum to which the human eye is sensitive is shown expanded. The scale on the large spectrum is a logarithmic scale of wavelength: each step on the scale corresponds to a tenfold increase in the wavelength of the electromagnetic radiation." (Wortman and Loftus 1981, pp. 110)

2. A picture using color opposites to demonstrate visual afterimages. (Difficult perhaps because the explanation is in the text instead of being by the picture.)

3. A line graph showing responses per minute when the subject is rewarded and not rewarded.

*4. A table on categories of meaning. (Difficult because of the heavy concentration of information.)

REFERENCES

The textbooks and references from which some explanations in this chapter were drawn are:

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Hinsie, Leland E., and Campbell, Robert Jean. Psychiatric dictionary. New York: Oxford University Press, 1970.

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Wortman, Camille B., and Loftus, Elizabeth F. Psychology. New York: Alfred A. Knopf, 1981.

Zimbardo, Phillip G. Essentials of psychology and life. Glenview, Illinois: Scott, Foresman, 1980.

Chapter 4

INSTRUCTIONAL TECHNIQUES FOR PSYCHOLOGY

Lists were provided in Chapter 3 of 464 difficulties in receptive communication that were experienced by students in introductory psychology classes; 108 of these were considered to be fairly serious. During the second year of the project the team outlined approximately forty-five instructional techniques and devices to use in preventing or overcoming some of these problems. The ideas were gleaned from participating faculty members, from references, and from earlier teaching experiences of team members. Each technique was tried out informally with a group of students, and if found promising, was developed further and tested on one or more groups as time permitted. Summaries of student evaluations for techniques used during the final trimester are given on the last page of this chapter.

Space limitations make it possible to describe only twenty-two of the techniques here. These procedures were selected to show a variety of first-hand experiences, simple demonstrations, transparency sets, charts, and guided study methods that can be used with classes of different sizes. The list, with pages where they can be located, follows:

INDUCTIVE LEARNING DEMONSTRATION

USING FLASH CARDS

Purpose: A device to lead students to discover the nature of incidental learning, as well as the importance of motivation for learning.

Description: Six very large flashcards are used. On each flashcard two rectangles of paper of different colors are glued; a variety of colors being used for the various cards. On one colored block on each flashcard a number is written, and on the other block a word is written. Students are directed to learn to associate the words and numbers as the cards are flashed. No mention is made of the colors until after the first learning experience. Then students discover they learned the word-number associations well, but learned very few of the colors incidentally.

Learning Principle: An inductive method of reasoning in which students discover principles or facts for themselves enhances learning better than mere exposition by the teacher.

Time Required for Use: 10-15 minutes

Preparation

Materials Required: Six cardboard rectangles about 9"x12"
Twelve rectangles of variously colored paper about 4"x6"
Felt lettering pen

Production Steps:

1. Write one different word on each of six colored rectangles.
2. Write a number on each of six other rectangles.
3. Mount a number and a word on each cardboard sheet (flash card) with ½" space between them.
4. Make six or more flash cards.

Teaching Suggestions

Ask the students to view each card for one second while they associate the words and numbers on the card. The students are to then question them on which words and numbers were paired. Next, question them on the colors:

1) What color was the card that bears the word 'sing'?
2) What color was the card that bears the number '3'?

Ask them why they learned the word-number combinations much better than the colors related to the words and numbers. Help them to generalize that (1) People learn what they intend to learn, and (2) Incidental learning is not very efficient learning.

3 (red)

sing (yellow)

(brown)

14 (green)

girl (blue)

(brown)

10 (yellow)

close (blue)

brown

9 (red)

town (yellow)

(brown)

CONTRASTING DESIGNS TO EXPLAIN

A PROCESS:

Chunking

Purpose: A device to teach the students the concepts of chunking, and the value of chunking of ideas into meaningful units for learning.

Description: Two designs on charts, using eight rectangles for each: In the first design the rectangles are scattered in a disorganized way. In the second design the rectangles are arranged as two "T's" one above the other with another horizontal pair at the base. Students are given five seconds to "learn" and afterward draw the first design. This is repeated with the second.

Learning Principle: A systematically organized body of knowledge can be perceived clearly and chunked into segments so it is better understood than a confused body.

Time Required for Use: 20 minutes

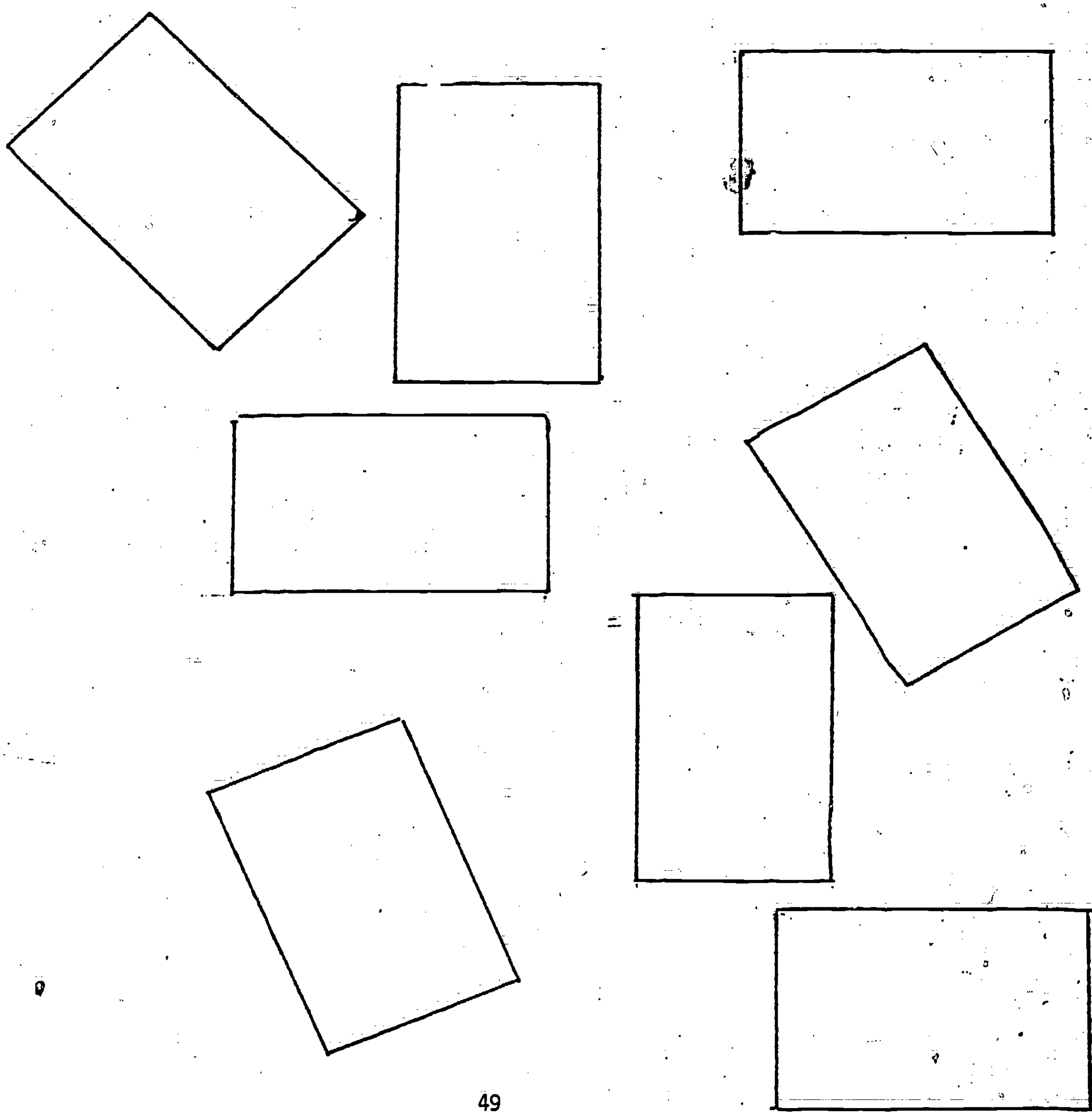
Preparation

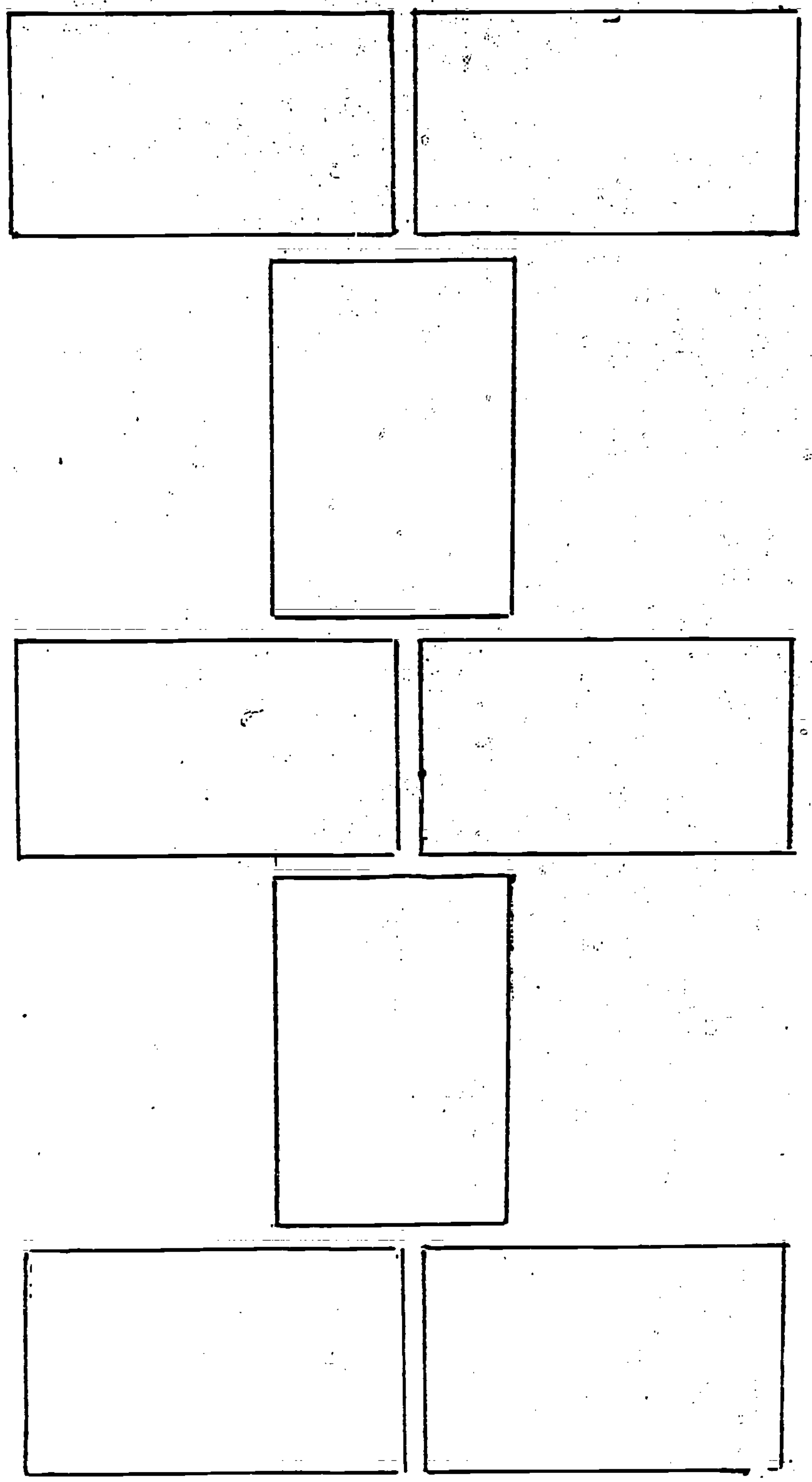
Materials Required: Two cardboard sheets measuring 14" x 17"
Felt tipped pens
A ruler

Production Steps: 1. Cut light colored cardboard sheets to size, 14" x 17" or larger
2. Draw eight equal rectangles of 2½" x 4½" on one cardboard sheet in a 'confused' design. (Refer to diagram.) Draw the eight rectangles in pattern on second sheet.

Teaching Suggestions

This device can be used with a group of any size. If preferred, the instructor can make the designs on transparencies and use them on an overhead projector. After students try to learn and draw both designs, discuss why they were much more successful with the organized one.





STRUCTURED OVERVIEW OF A CHAPTER

Purpose: This is a device to aid students in perceiving and relating the main ideas in a chapter.

Description: This overview can take several different forms: linear outline, flow-chart, radial diagram, or any other form that the instructor likes for the material concerned. It can be made on a transparency, a chart, or a duplicated sheet that is distributed to students. (Two examples are provided on the following pages.)

Learning Principle: Structure contributes both to understanding and to retention of information.

Time Required for Use: Indefinite; used at various times during study.

Preparation

Materials Required: The text chapter for reference, transparencies or chart paper, and the chalkboard or overhead projector for initial presentation.

Production Steps: 1. Analyze the terminology of the unit of study and record all the terms, symbols, and proper names which are necessary for understanding the content.

2. Arrange the terms in a diagram that demonstrates the interrelationships of the terms and ideas. Diagrams can employ either a linear format, a flow chart form, a radial form, or an outline form.

3. Add to the diagram any words you believe to be already known by the students but that are required to clarify the relationships.

Teaching Suggestions

1. When the unit is introduced for the first time, the diagram is reconstructed in front of the class on the chalkboard, on a chart, or on an overhead transparency. As this is being done, the instructor explains the rationale underlying the organization of the diagram.
2. The students should be encouraged to contribute as much information as they can to the process. In smaller classes or in recitation sections, this procedure can be used as a diagnostic assessment of the students' previous knowledge or experience with the subject area.
3. During the course of the unit, refer back to the diagram to help the students see the major ideas and how they fit together. Students should not be required to memorize the diagram. Rather, they should be encouraged to view the diagram as a framework into which new information can be placed as they encounter it in recitation sections, labs, large group lectures and reading assignments.

(See examples on the next two sheets.)

THE GROWTH OF PSYCHOLOGY

Structuralism

William Wundt
- Leipzig lab
- objective introspection
- atoms of thought
- pure sensations without associations
- introspectionist

Edward Titchener
- science of consciousness
  - physical sensations
  - affections or feelings
  - images

Individual Differences

Francis Galton
- mental tests
- genius
- mental imagery
- word association

Functionalism

William James
- mental associations
- automatic
- adaptation
- functionalist theory
- subjective introspection
- associations

James R. Angell

John Dewey

Behaviorism

John Watson
- Little Albert
- behaviorist theory

Ivan Pavlov
- stimulus
- response
- conditioning

Gestalt Psychology

Max Wertheimer

Wolfgang Köhler

Kurt Koffka
- perception
- gestalt

S-R Psychology

B. F. Skinner
- reinforcement
  - reward
- Skinner box

Psychoanalytic Psychology

Sigmund Freud
- unconscious
- motives
- Freudian Slips
- infantile sexuality
- dream interpretation
- talking cure
- psychoanalysis

Cognitive Psychology

E. C. Tolman
- information

Jean Piaget

Existential Psychology

Jean-Paul Sartre

Rollo May

R. D. Laing
- alienation
- inner sense of identity

Humanistic Psychology

A. Maslow
- nonverbal experience
- unity of mind and body
- communication through touch
- altered states of consciousness
- letting go
- self-actualization

52

AREAS WITHIN PSYCHOLOGY TODAY

School Psychologist | Industrial Psychologist | Social Psychologist | Developmental Psychologist | Physiological Psychologist | Clinic Psychologist

METHODS OF PSYCHOLOGY

Naturalistic-Observation Method
- Natural settings
- observer bias

Experimental Method
- hypothesis
- unbiased subjects
- independent variable
- dependent variable
- experimental group
- control group
- experimenter bias

Correlational Method
- longitudinal method vs. correlational method

Ethics in Psychology
- ethical standards controversy
- code of ethics

Pure Versus Applied Psychology
- pure research
- applied psychology

Using Animals in Psychological Research
- genetic history
- immediate environment
- social complications

New Directions in Psychology
- environmental psychology
- psychogeography
- ecological psychology
- architectural psychology

Chapter 6 - MEMORY

Measuring Retention (pp. 184-187)

Recall
- verbatim
- serial recall
- free recall

Recognition
- multiple choice test

Savings
- relearning

High School Memories
- recognition
- recall

Traditional Studies of Memory

Ebbinghaus
- retention curves
- overlearning
- nonsense syllables

Muller
- paired associates

The Three Levels of Memory (pp. 187-195)

Sensory Register
- sensory information
- verbal label for raw image

Short-Term Memory (STM)
- seven plus or minus two
- chunking meaningful units

Retention in STM
- rote rehearsal
- immediate recall

Transfer to LTM
- elaborative or constructive rehearsal
- retrograde amnesia
- coding
- physical coding
- sematic coding

Long-Term Memory (LTM)
- organized
- call-up
- indexes or associations
- acoustic coding (phonetic)
- visual coding
- reconstructive memory
- retrieve

Retrieval Process
- serial scanning
- cues
- mnemonic device
- available memory

Tip of the Tongue Phenomenon
- TOT
- phonetic
- semantic

Forgetting (pp. 195-207)

Forgetting Isolated Facts
- decay
- interference
- trace decay theory
- interference theory
- memory trace
- proactive inhibition
- retroactive inhibition
- primary effect
- recency effect
- cued-recall tests

Forgetting Meaningful Material
- meaning
- serial reproduction

Motivated Forgetting
- repression
- hysterical amnesia

Organic Amnesia
- global dementia amnesia
- Milner's syndrome

Mnemonic Devices
- topical system

How to Improve Learning and Retention
- distribution of practice
- arousal
- whole versus part learning

Zeigarnik Effect

Repression

Biological Bases of Memory (pp. 207-211)

Location of Memory
- phrenology
- storage
- retrieve
- formation

Unit of Storage
- memory trace
- neural processes
- reverberating circuit
- cell assembly
- ribonucleic acid

CONCEPT ATTAINMENT TECHNIQUE

TO EXPLAIN "CONCEPT"

Purpose: Technique to develop understanding of the term "concept". Develop understanding that concepts are attained through various experiences, one being categorization of features as appropriate or inappropriate.

Description: Using a concrete term for which the group has no concept, the instructor leads the students to ask questions about its attributes until they have listed enough appropriate attributes so that they have some understanding of the concept. In this way they discover that the word is only the label for the concept and they must have some types of experiences to attain the concept, or meaning.

The instructor can add that the concept will become more clear and accurate as they have more experiences with it.

Learning Principle: Active involvement in guided discovery is productive even at the symbolic level.

Time Required for Use: 12-15 minutes

Preparation

Materials Required: 1. A very unusual word that labels a concept having attributes that are fairly concrete. (An abstract concept probably will take considerably longer to develop.)
2. Classroom chalkboard, chalk.

Production Steps: 1. Write the strange word at the top of the chalkboard.
2. Under it, head one third of the board with the word "yes", the middle third with "sometimes", and the other third with "no".

Teaching Suggestions

1. Place the strange word, such as "uwargida", on the chalkboard. (Do not tell students it means "head-wife" in the Hausa Language.)
2. Demonstrate the pronunciation and ask them to say it several times. (oo-wahrrr-gee-duh, with /g/ as in "get", and the stress on the last syllable)
3. Ask them what the word means. Then explain that they have "learned a word" without learning the concept for which it stands.
4. Lead them to ask questions about the concept, such as: "Is it living?" "Is it a form of plant life?"
5. Respond by listing "living" on the yes-side of the board and "plant life" on the no-side.
6. Continue the process for a few minutes until lists are quite long.
7. Ask students to keep examining the yes-list for applicable characteristics until somebody can give something close to the right meaning--head-wife.
8. Explain that the head-wife is the senior wife in a Moslem family, but this cannot be fully understood without more experience. Students now have a concept for uwargida, but not a fully accurate concept.

"CONCEPT" EXPLAINED THROUGH CONCEPT ATTAINMENT TECHNIQUE

(An Example)

---

uwargida

Yes	Sometimes	No
living thing	a mother	plant life
wears clothing	favorite daughter	farm animal
female	old	wild animal
member of a family		child
human		is eaten as food
wife		male
housewife		has much power
has power		a servant
has limited power		holds religious position
is first		chief secretary
first-wife or head-wife		author
		actress
		entertainer
		seamstress

Note: One can mention that all of the attributes listed are, themselves, symbols for additional concepts.

THREE-STEP ABSTRACTION PROCESS FOR TEACHING A COMPLEX CONCEPT

Purpose: A technique to simplify and dramatize a concept, such as "shaping".

Description: (1) Students study a sequence of drawings.
(2) They briefly describe what is happening in each.
(3) They abstract the meaning of the events, and form a statement of a principle or generalization.

Each picture or cartoon represents a step in the process of shaping: the reinforcement of successive approximations of desired behavior. Students use the illustrations as a starting point to analyze the subparts of the concept first in layman's language and then in technical language. Finally the student writes a definition for the technical terms, "shaping".

Learning Principle: An inductive process results in understanding.

Time Required for Use: 10-12 minutes

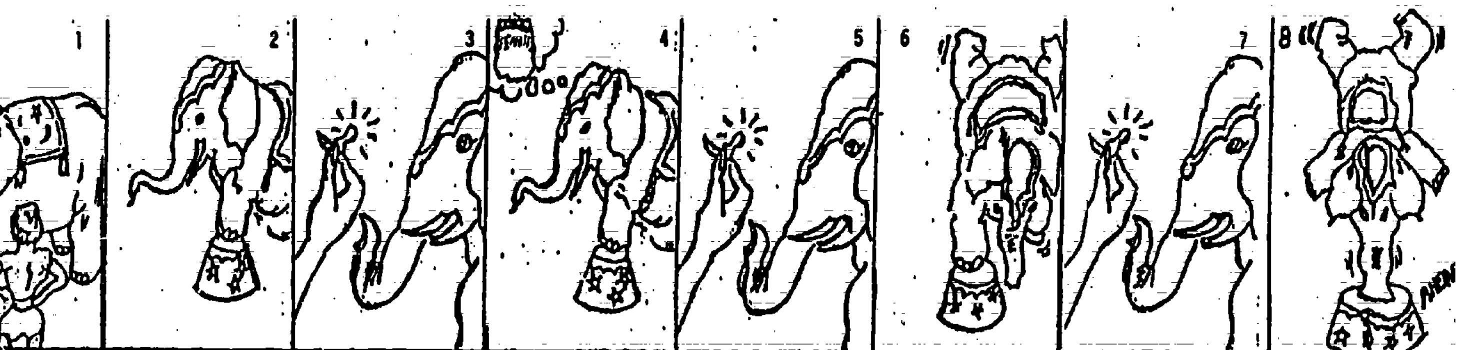
Preparation

Materials Required: Picture sequence

Production Steps: 1) Draw simple cartoon strip at the top of a piece of paper, showing each step in reinforcing behavior.
2) Number each picture.
3) Below each picture, draw two boxes for student responses.

Teaching Suggestions

This sheet should be distributed in class during the appropriate lecture. It is important that the cartoon remain simple yet show sequential progression. The student views each visual illustration and writes down exactly what is happening in the box below the appropriate picture/cartoon. Next the student writes the psychological description of what is happening in the third box. This step can involve interaction among peers. Finally, the student writes a definition for the technical term. This step can be altered to include student-developed study questions or self reflections about the overall concept.



er es ant.	Elephant steps on drum from curiosity.	Elephant receives a peanut.	Elephant steps an drum again.	Elephant is rewarded with another peanut.	Eventually elephant balances on one foot.	Elephant receives a peanut reward.	Elephant balances on its trunk.
er hes ed vior cur.	First desired behavior.	Reinforcement meant to bring about learning.	Behavior repeated because of past reward.	Reinforcement meant to strengthen learning	Next behavior in desired sequence occurs.	Reinforcement	Another behavior in desired sequence

haping is a method of producing learned behavior by reinforcing the learner for displaying closer and closer approximations of the desired behavior.

(Note: the hand-written entries are the responses a student might make on the form.)

DIAGRAMATIC REPRESENTATION OF AN EXPLANATION

Purpose: A device to teach the concept of regression to the mean.

Description: This device is a diagram of the normal curve on a base transparency with two separate overlays. One overlay shows with symbols (or dots in three different colors) the distribution of student scores on a test. One symbol or color indicates the scores between minus-one and plus-one standard deviation around the mean. The other two symbols or colors show the distributions of scores beyond minus-one SD and above plus-one SD. The second overlay the distribution of scores on a second administration of the test to the group. Now some of the students who scored very high or very low scores the first test, have scores on the second test that are closer to the mea this is indicated by using the same symbols or colors that stood for medium, and low groups of individuals previously. The symbols now will the class that there is a tendency for students who have scores far from the mean on a first test to move somewhat toward the mean on a later retest--regression toward the mean.

Learning Principle: Diagramatic representation helps students to learn through the visual mode, especially when the material is quantitative.

Time Required for Use: Used as part of a lecture, and will vary with the material covered.

Preparation

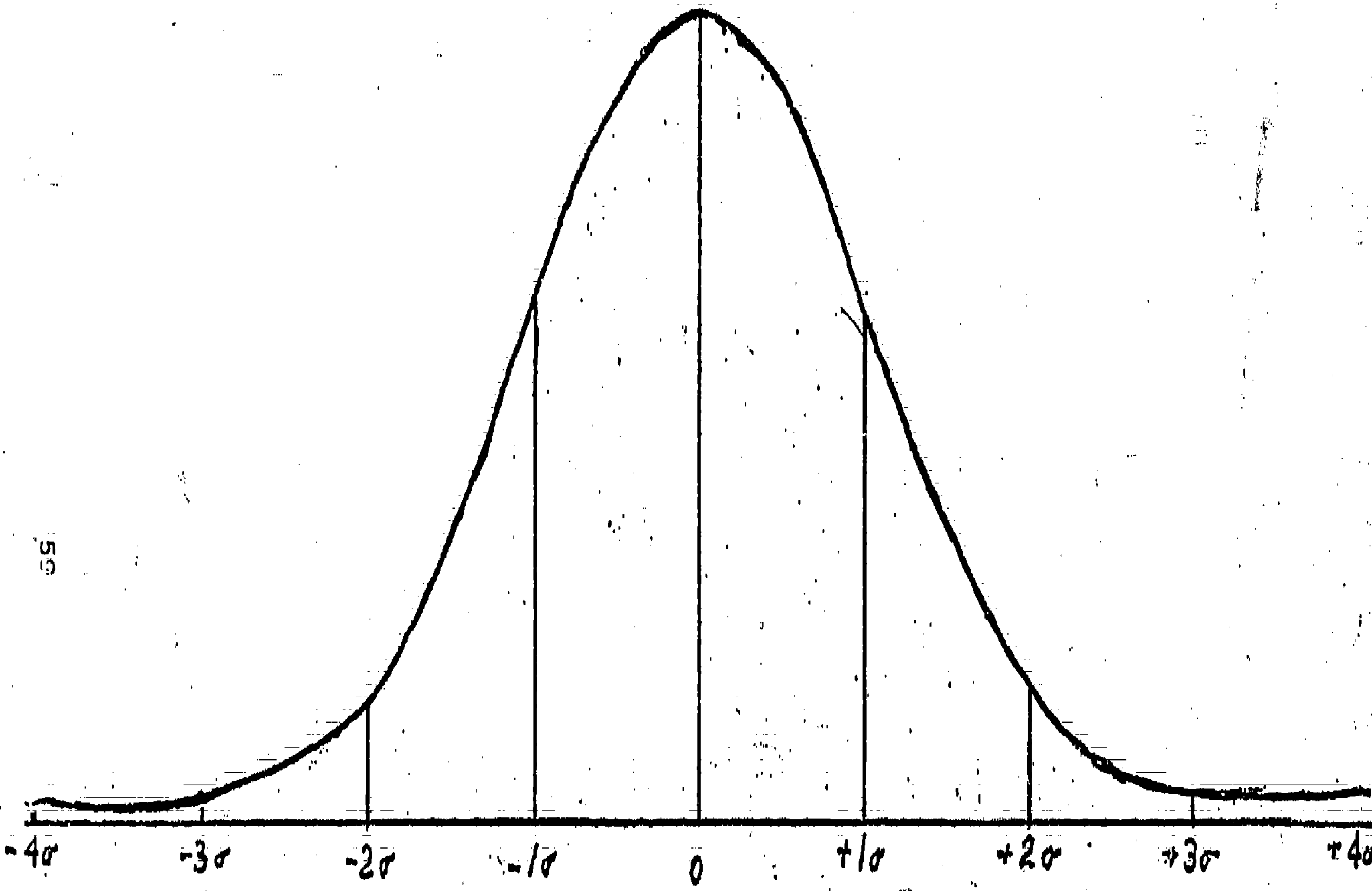
Materials Required: Two cardboard sheets measuring 8½"x11"; felt tipped pens; pencils. Transparencies and colored felt-tip pens.

Production Steps:
1. Draw the diagram of the normal curve.
2. On an overlay of the normal curve show the scores for a first test.
3. On the second overlay show how some scores regressed to the mean on the second day of test with the same test.

Teaching Suggestions

The technique can be presented during the lecture or in the recitation section. The diagram illustrates the technical term "regression toward the mean" when a test is taken by the same group of students at two or more different times.

(See illustrations on the next three pages.)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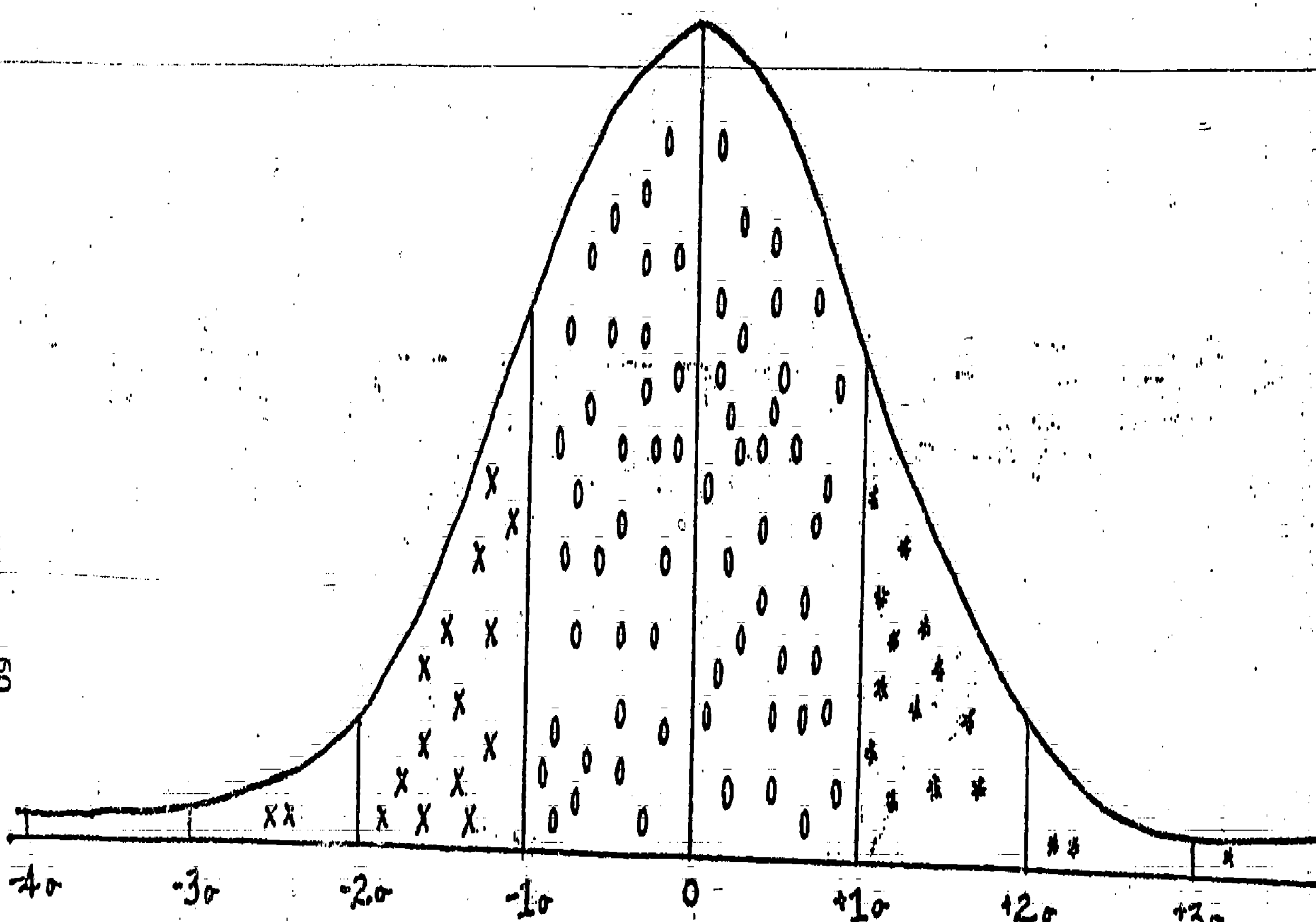
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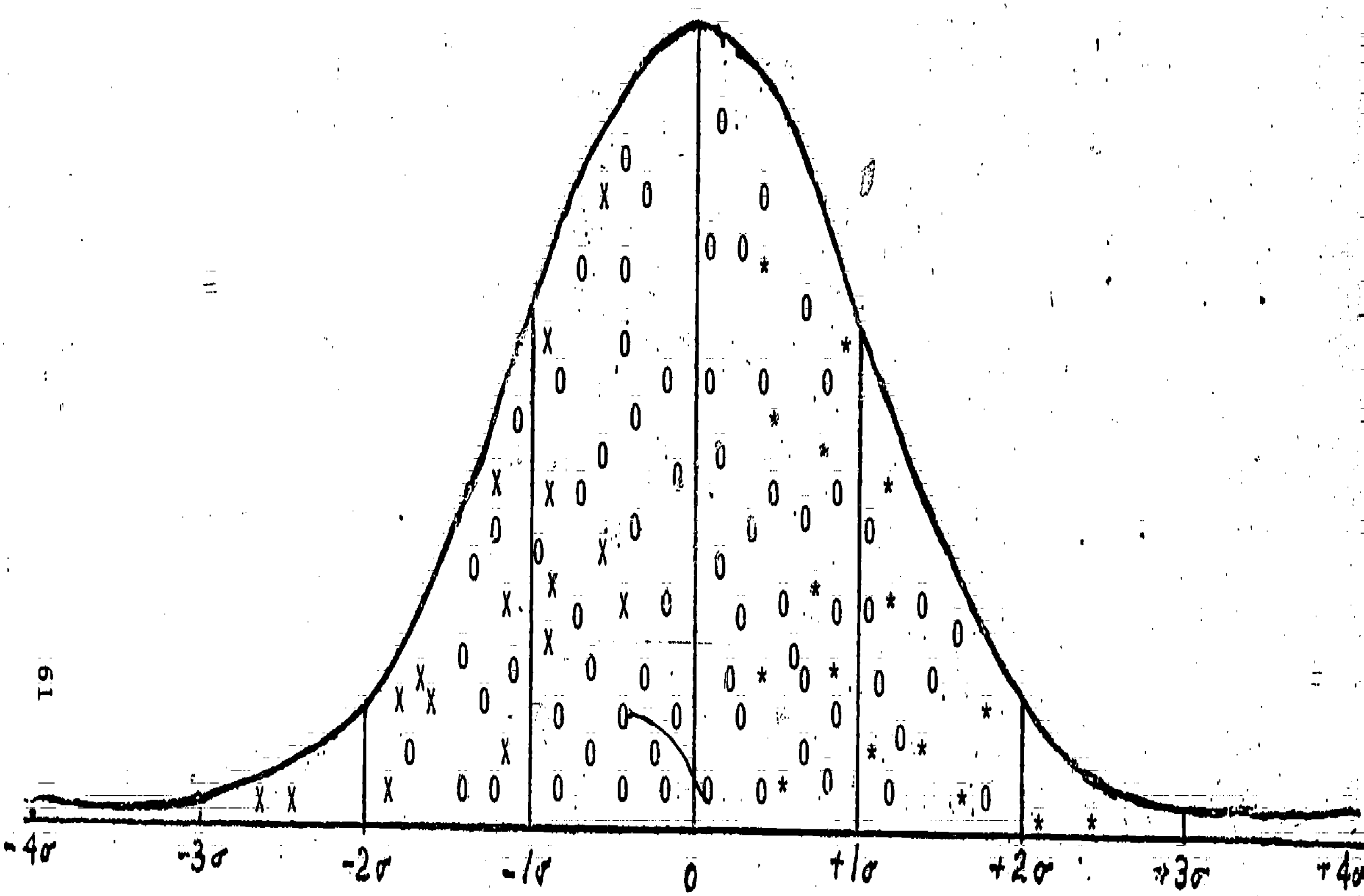
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CLOZE TECHNIQUE FOR TEACHING COMPONENTS OF THE CENTRAL NERVOUS SYSTEM

Purpose: A technique to engage students in an active procedure for learning the parts and functions of the components of the Central Nervous System (CNS). It provides students with a clear visual representation of the structure of the basic unit of the CNS.

Description: This technique utilizes one or more worksheets having wide middle columns in which a description of the central nervous system is typed, with blank lines left where certain important terms need to be written in. The terms are listed in the lower margins. The CNS is explained with drawing on transparencies or from the textbook. The Central Nervous System is a complex network of communications channels with numerous components. Students are required to learn the major technical terms associated with the various parts of the CNS as well as the functions of the neuron. The technique introduces the students to this information via a socratic mechanism which calls upon the student to utilize visual, auditory and motor modes of learning.

Learning Principle: Encoding reduces information to manageable chunks for storage.

Time Required for Use: 30 minutes

Preparation

Materials Required: Ditto masters of completion sheets, three transparencies of nerve structures, duplicating paper, overhead projector

Production Steps: 1. Develop a passage which explains and defines the technical terms associated with the major components of the Central Nervous System. Specific emphasis should be placed on the functions and parts of the neuron. The selection should include at least ten technical terms, each followed by the basic definition.

2. A ditto master is turned in a horizontal fashion and two lines are drawn creating 2½ inch margins on both the left and right sides. A six-inch wide section is left in the middle. A one-inch margin is left at the bottom of the sheet. The three sections are titled (left to right): (1) Questions, (2) Lecture Content and (3) Additional Notes. Lay out one or more ditto sheets in this fashion.

3. Next the selection on the CNS is typed (double spaced) into the middle section of the ditto masters. Each technical term is deleted and a space large enough to permit the students to insert the term is provided. The deleted technical terms are randomly placed in the one inch section at the bottom of the page. Duplicate enough copies for the class members.

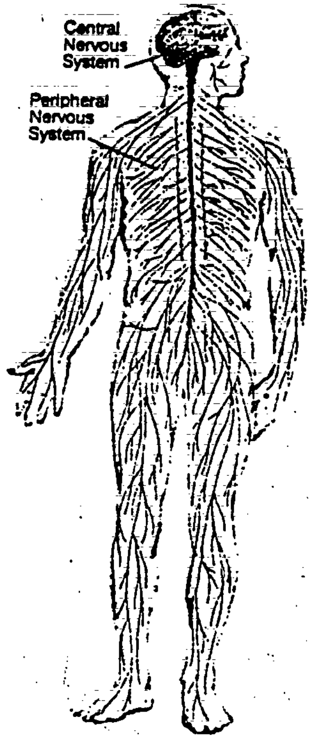
4. Finally, develop an overhead transparency of the CNS and also one of the neuron. The major components should be labeled and should correspond to those in the passage.

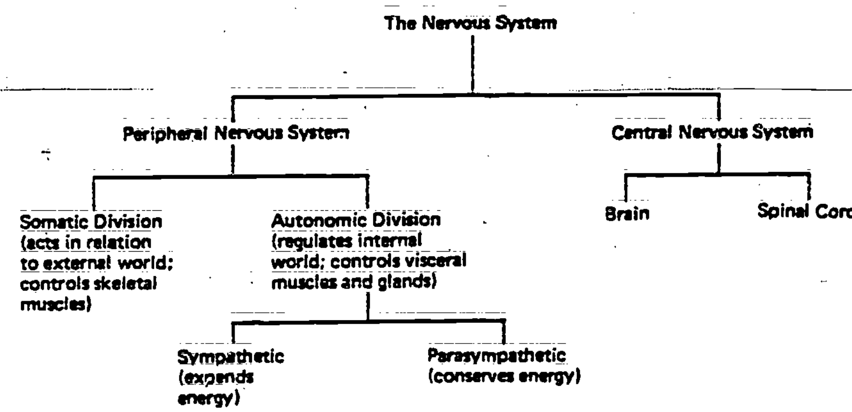
Teaching Suggestions

1. Using a discussion method the instructor presents the material on the CNS. Transparencies are utilized during the presentation.

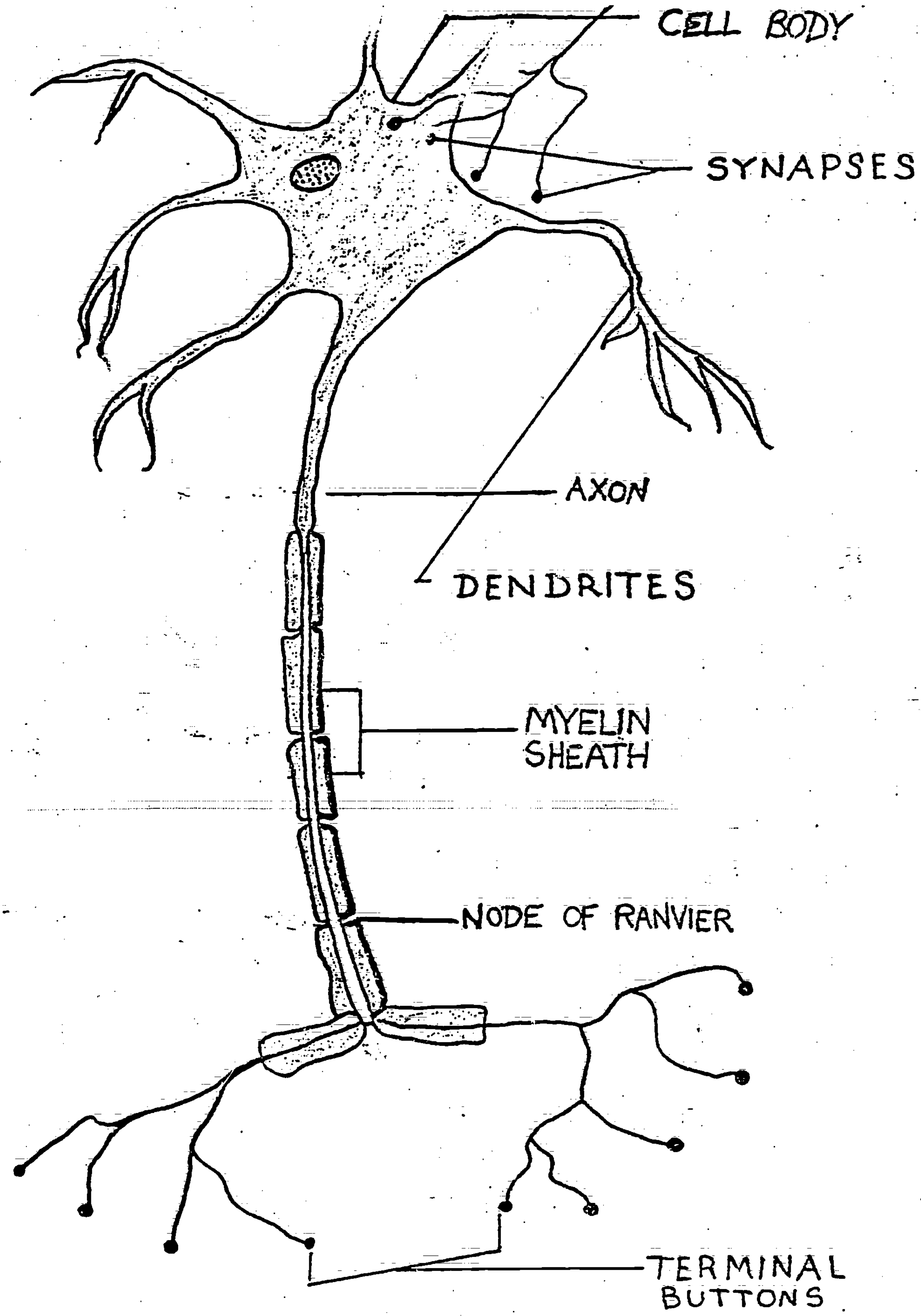
2. The student utilizes the cues and context to fill in the blanks on the worksheet as the instructor questions the class. Explanations follow each question segment. Additional study notes on these explanations are listed by the student in the "Additional Notes" column.

3. After the lecture or during the latter part of the class session the student writes down questions in Column One to guide later studying. The student refers to the content column and the notes column in developing both surface questions and depth questions.





(Taken from Wortman, Camille B. and Loftus, Elizabeth F. Psychology. New York: Alfred A. Knopf, 1981, p. 74-75)


CELL BODY
SYNAPSES
AXON
DENDRITES
MYELIN
SHEATH
NODE OF RANVIER
TERMINAL
BUTTONS

Study Questions	Completion Sheet Lecture Content	Additional Notes
	The human body consists of a web of nerves that control our various reflex activities. The ________________ is made up of a network of communication channels that spreads to every part of the body. In our brain, the individual ________________ usually functions much as we would, if we were employed by a corporation - which is to say that each works fairly continuously at its own tasks and does its best to cooperate with its neighbors. Most of our body's ____________, the basis unit of the nervous system, are concentrated in the ________________ ________________ which consists of the ____________ and the ____________. For instance, neurons that collect messages from inside and outside our body and carry those messages to our spinal cord or to the brain are called ____________ (or ____________) neurons. And neurons that carry messages from the spinal cord or our brain to our muscles and our glands are called ____________ (or ____________) neurons. The central nervous system branches out into the ____________ ________ which can be further sub-divided into the ____________ and ____________ nerves.	

somatic
switchboard
neurons
nervous system

dendrites
cell
synapse

central nervous system
parasympathetic
peripheral nervous system

nerve cell
motor neurons
spinal cord

sympathetic
cell
terminal

myelin
cell body
sensory

axon
brain
autonomic

(Work Sheet)

TRANSPARENCY WITH OVERLAYS TO DEMONSTRATE THE CHARACTERISTICS OF THE BLIND SPOT

Purpose: A device to teach the technique term "blind spot" in the eye.

Description: Every human being has a blind spot in each eye where the optic nerves converge on the retina; yet most people manage to see without much difficulty. This transparency with overlays is designed to acquaint students with the structure of the eye in relation to the blind spot and with the effects of an enlarged blind spot.

Learning Principle: Visual aids promote learning.

Time Required for Use: 10-20 minutes

Preparation

Materials Required: Four transparencies, felt tipped pens

Production Steps: 1. On a transparency draw the picture of the eye and label the eyelid, iris, cornea, pupil, lens, retina, optic nerve. Lay this over Transparency #2.

2. Make a second transparency and indicate the enlargement of the blind spot if there is damage to the neural cells and receptors (Base Transparency).

3. On another transparency (Overlay #1) show a normal visual image.

4. Make a fourth transparency of the picture of the eye showing the image when there is an enlarged blind spot.

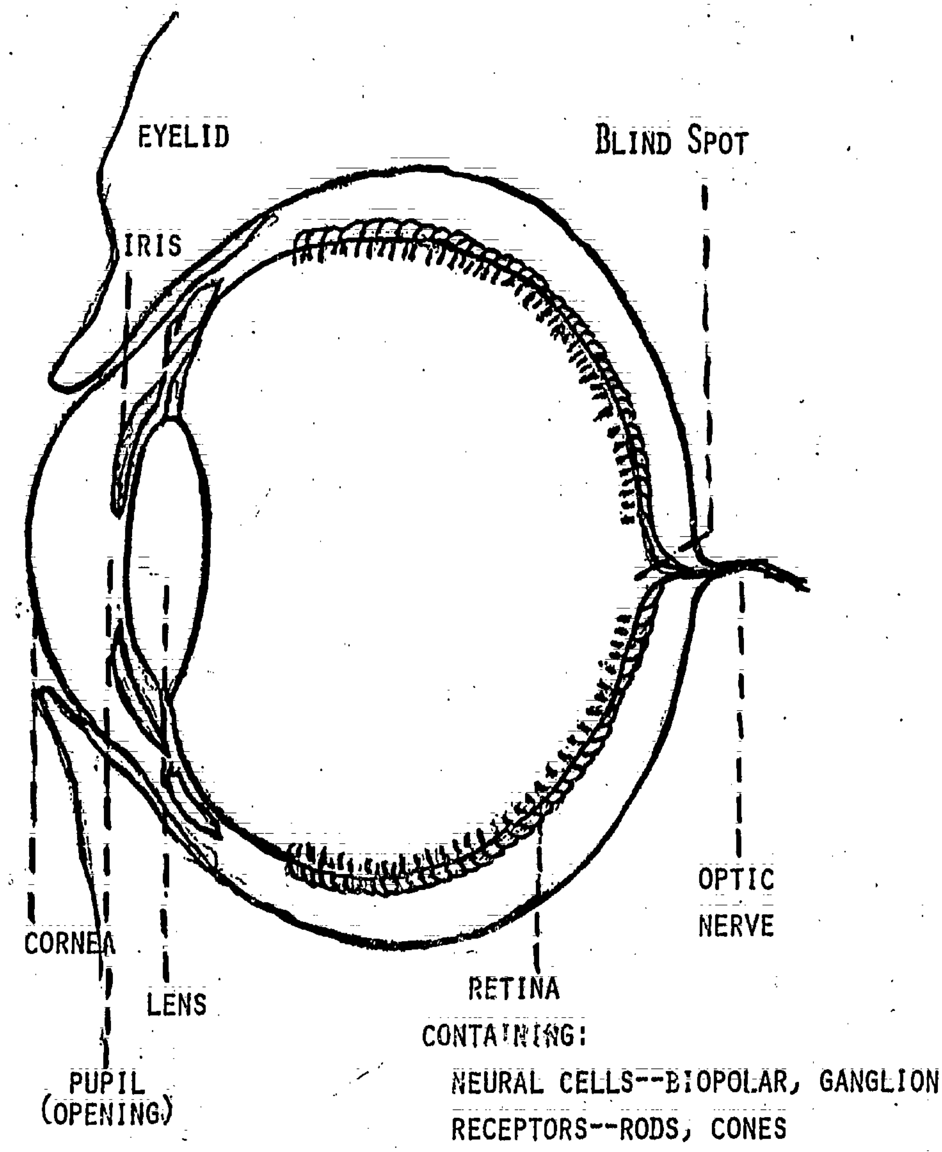
Teaching Suggestions

In a large group lecture, show transparency of the normal eye, image of the normal eye; the enlarged blind spot in the eye, and defective image caused by an enlarged blind spot.

(See transparency illustrations on next three pages.)

EYE WITH
ENLARGED BLIND SPOT

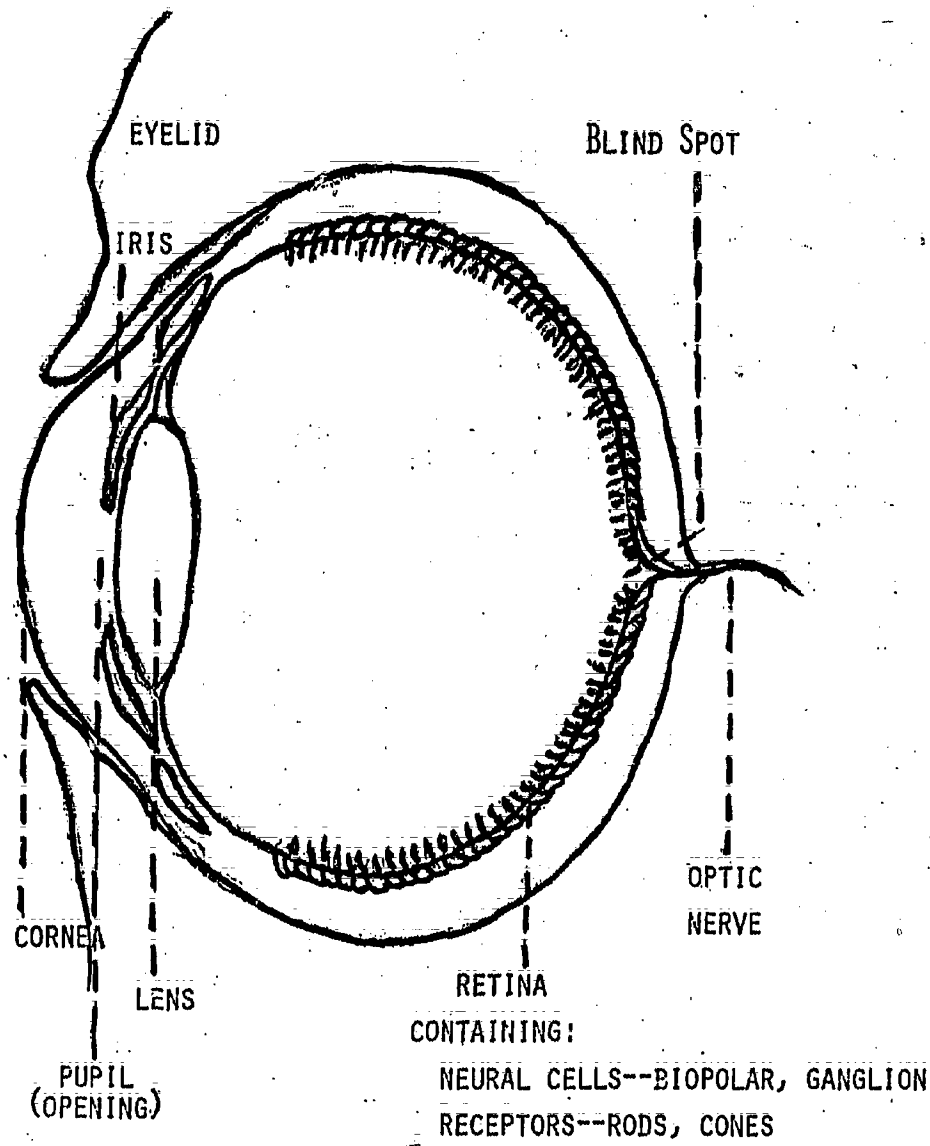
Damage to nerves in
the retina can cause
an enlarged blind spot.



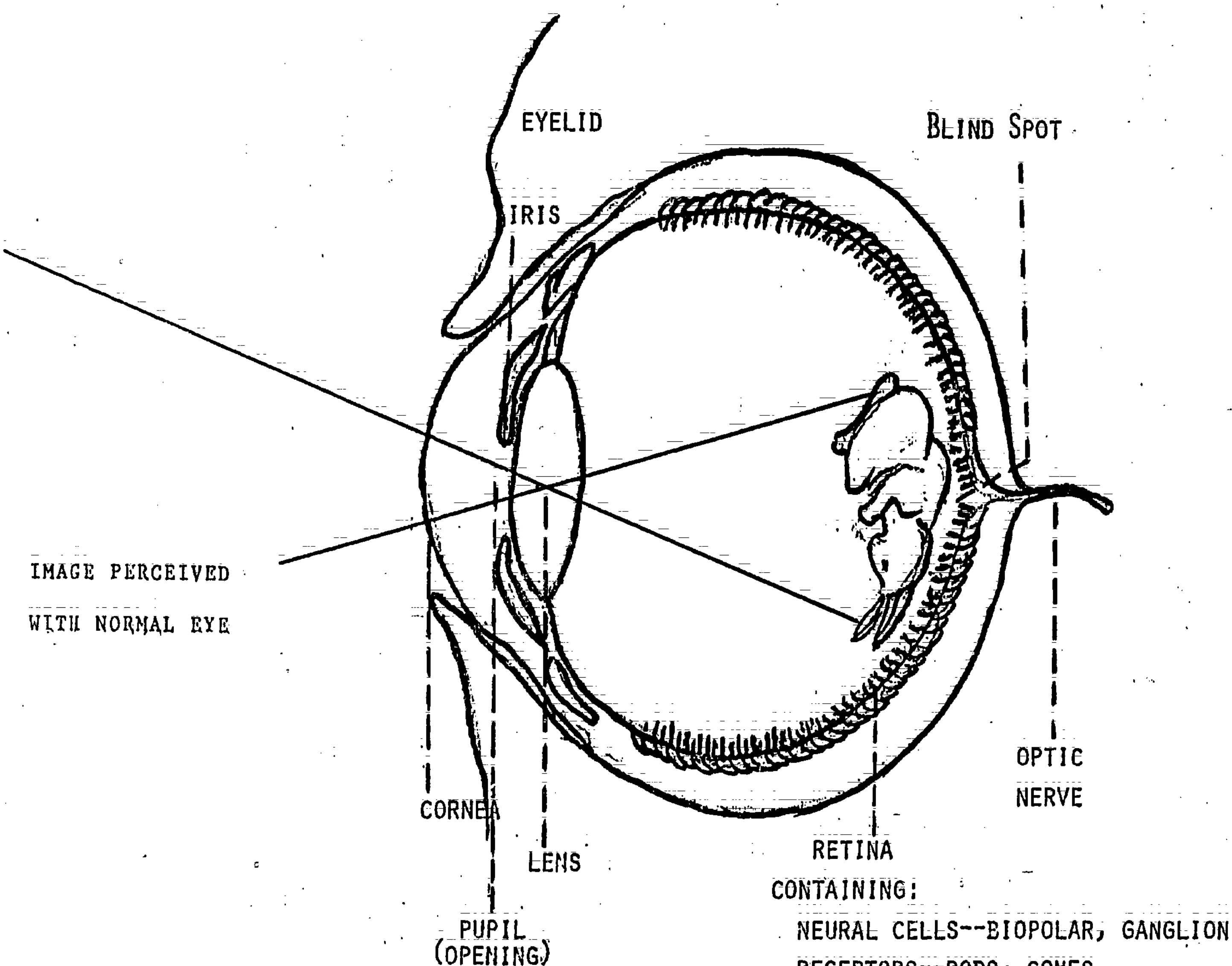
(Base Transparency -
Shown as second view)

THE NORMAL EYE

HAS A TINY BLIND SPOT
WHERE THE OPTIC NERVES
JOIN THE RETINA.



(First Overlay -
Shown over base transparency
as first view)



(Second Overlay)

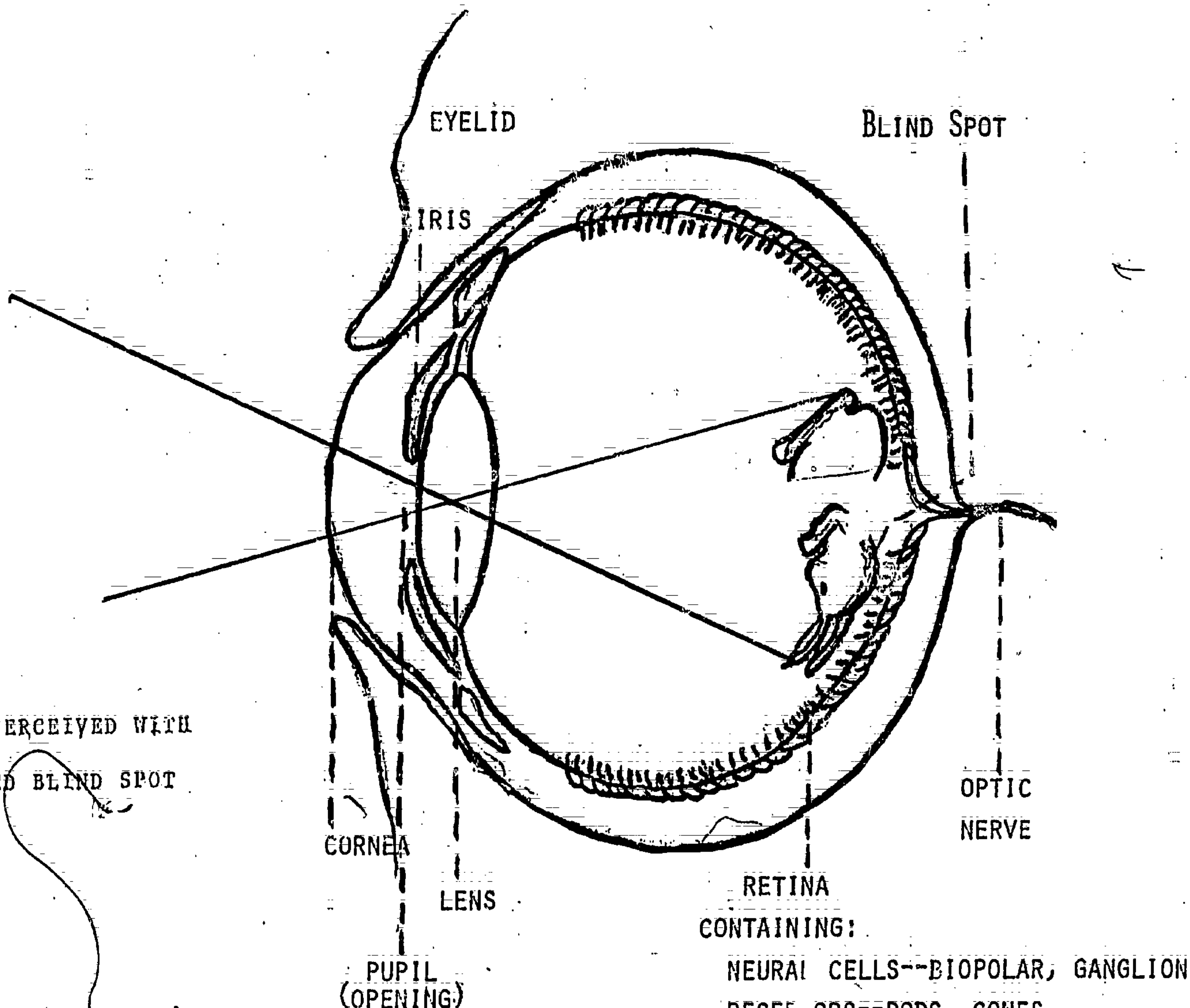


IMAGE PERCEIVED WITH
ENLARGED BLIND SPOT

(Third Overlay)

SET OF SLIDES FOR INDUCTIVE LEARNING OF DEPTH AND DISTANCE CLUES

Purpose: A device to stimulate inductive learning of depth and distance clues provided for monocular vision.

Description: Five or six slides are used to help students discover and explain how these aspects of monocular cueing help the observer judge the depth and distances of objects they see: (1) interposition, (2) relative size, (3) linear perspective, (4) aerial perspective, and (5) shadow.

Learning Principle: The iconic mode of learning is an excellent substitute for first-hand experiences when first-hand experiences would be too time-consuming.

Time Required for Use: 15-25 minutes

Preparation

Materials Required: An appropriate set of slides from an art collection, or a 35-mm camera and projector.

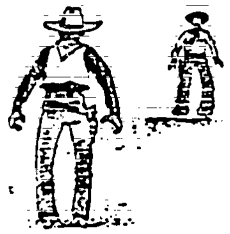
Production Steps: In the one case, borrow a set of art slides from the college library and select those necessary to teach the desired ideas. (See examples on next page.)

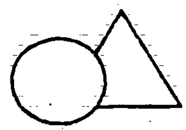
In making one's own set of slides, the instructor can use a 35-mm camera and find suitable situations to photograph on the college campus. Among the possibilities are: one person at close range with a couple of others at a distance, two objects known to be of different sizes with the larger one at a greater distance, a street from close-up to a great distance, a group of moving people or cars taken from high up in a tall building, trees or other objects that offer strong shadows.

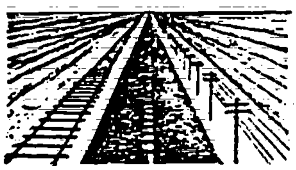
Teaching Suggestions

1. After discussing how binocular vision helps people obtain depth in images, ask students whether they can perceive any depth or distance with one eye closed.
2. When they have speculated on this, use the slides one at a time to help them to discover the ways in which depth and distance can be perceived with monocular vision.
3. Use a slide or print of Hogarth's humourous engraving of a fisherman (1754), and ask students to find the errors in perspective that Hogarth put into the picture to puzzle and amuse people.

(See illustrations provided on next sheet.)







37. Engraving by William Hogarth of a fisherman (1754). Hogarth combines various views and perspectives to produce an impossible picture.

ACCORDION CHART ILLUSTRATING LANGUAGE STYLE

Purpose: A device to clarify a specialized language construction using common words: "removed in time" or "removed in place".

Description: The first accordion chart is a device used to teach the language style of "removed in time". It consists of a series of pictures illustrating "washing machine" as the term has been used since 1770. It explains the possible misperception of a concept that is "removed in time", because the washing machine of 1770 was so different from that of 1980.

Learning Principle: Pictures clarify abstract ideas.

Time Required for Use: 5 minutes

Preparation

Materials Required: Five or six cardboard sheets measuring about 8½"x11"; felt tipped pens; pencils.

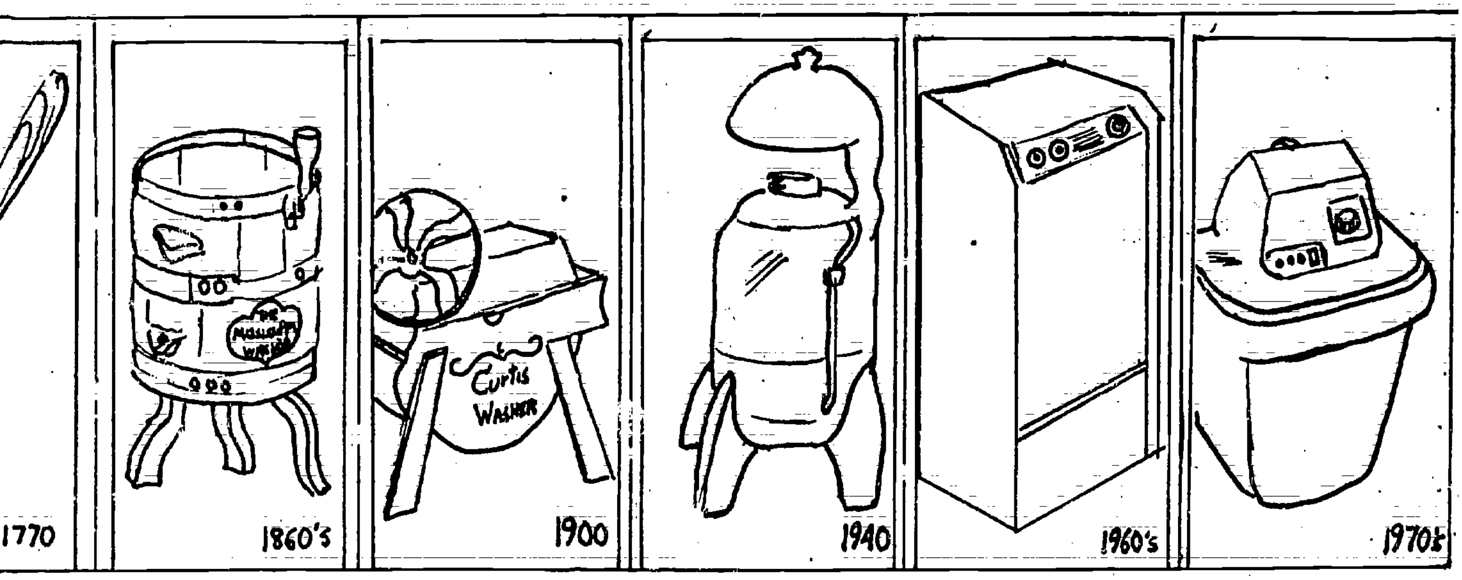
Production Steps: Draw the pictures of the models of washing machines from 1770 to the present day (five or six models), one on each of the cardboard sheet. Hinge cards serially so that they can be folded.

2. (a) To make a second device, on "removed in time" draw a picture of a boy standing with his puppy on one card.
   (b) Draw the boy doing something else without the puppy on four cards.
3. (a) On the fifth card, draw the boy "thinking" of the puppy, which still is not present.
   (b) Hinge all the cards in order 1-6, so that they can be folded.

Teaching Suggestions

1. Ask the class to read or listen to some statement about the use of a washing machine in the days of the Revolutionary War. Then ask them to describe the washing maching that they visualized as they listed or read.
2. Show them the newest type of washing machine on the accordion folder and ask how many visualized such a machine for the event in Revolutionary days. Continue this process, using each older version of the machine, until you have reached the 1770 version. Ask how many had that image in mind. (Probably none.) Explain that they were trying to visualize idea that was "removed in time", and that their lack of experience in that time caused inaccurate imagery. Consider other ideas that they read about which are removed in time.
3. Follow a similar process with the accordion chart on "removed in space". Lead them to see that the boy can still visualize his puppy quite accurately, even though it is removed in space. Other objects might be impossible to visualize accurately when removed in space if the person has had little or no experience with them.

(See illustration on next page.)


1770
1860's
Curtis
Washer
1900
1940
1960's
1970's


AHEARN

TECHNICAL VOCABULARY LOG FOR STUDY TRIADS

Purpose: 1) To aid the student in discovering his/her strengths and weaknesses in technical vocabulary.
2) To enhance learning process through peer teaching and peer support.

Description: Students are grouped into triads for ongoing reinforcement and review.
1) Each student keeps a log of problem words, phrases, concepts, etc., encountered within the current chapter or section.
2) Weekly throughout the course, the students are grouped into triads and their problems are discussed within the group.
3) Any problems that remain unresolved or unclear within the group are submitted to the instructor and are discussed in the next class.

Learning Principle: Review and elaboration through peer interaction can enhance learning.

Time Required for Use: 30 minutes

Preparation

Materials Required: Small looseleaf notebooks, paper and alphabetical dividers (for students)

Production Steps: 1) List of problem terms compiled from previous student responses.
2) Prepare log sheet with problem areas listed and a space provided for the student to record definitions.

Teaching Suggestions

(1) The triads should meet at regular intervals, either on a weekly basis or at the end of each topic or chapter.
(2) There are various ways to group the triads: a) student selection, b) instructor selection, c) random grouping.
(3) Triad teams should test each other on terms, and discuss differences in their understandings.
(4) Any problems that remain unresolved or unclear within the group can be submitted to the instructor and be discussed in the next class.
(5) In large classes, this procedure can be included in laboratory sessions, in recitation sections, or in cluster groups. A teaching assistant can interact with each triad to clarify problems.

(See direction sheet for students that follows.)

Directions for Technical Vocabulary Log

Since an important aspect of this introductory course is to help you learn the basic concepts and vocabulary of the field of psychology, we are asking you to develop a collection of terms that are either of particular interest to you or are particularly troublesome. Research indicates that an improved understanding of technical terms and concepts contributes to reading speed and comprehension of the subject matter. An effective means of accomplishing this goal is to become aware of the new technical terms that you hear in lectures or read in the text. To make these technical terms your own, you must listen actively for them, record them and also analyze them.

To find these terms, follow a simple and helpful rule. Select any word you think is of importance in mastering the ideas in this course. For example: 1) words used in class lecture, lab sessions or small group sessions, 2) words encountered during assigned or supplementary reading, and 3) words used by your professors, teaching assistants and classmates. The following instructions will assist you in developing your log and in sharing the terms with your classmates:

1. Obtain a 7" by 4½" looseleaf notebook, paper and alphabetical dividers.

2. Collect technical terms and concepts on a daily basis, listing each word at the end of the notebook. Be sure to <u>number</u> and <u>date</u> each entry.

3. Rewrite each word in the correct alphabetical section. Then write the sentence you heard or read containing that word, and the dictionary pronounciation with appropriate diacritical markings.

4. Note any unusual prefixes and roots, their derivations and meaning. Then list the definitions of the word, starring (*) the definition that fits the original sentence. Use your class text or a technical dictionary to assist you with this step. Next write your own sentence using the word.

5. Review the words weekly, attempting to learn their meanings, roots and prefixes; orally recite the words in sentences. Gradually eliminate studying of mastered terms. Use a check system on words learned, omitting any word having three checks marked to indicate three unsuccessful attempts at learning and reviewing.

6. The vocabulary collection will be evaluated on accuracy and completeness at the end of the term. A collection will be considered incomplete if the total number of words is not stated and if the format and instructions are not followed.

7. It will be most useful to add terms daily. <u>Under no circumstances are you to let a week lapse without catching up</u>. Falling behind will make a regular and easy task much more difficult. In addition, spaced learning improves long-term memory.

8. Each week we will break up into small groups so that you may discuss the problems that you encountered with your fellow group members. If at the end of a session you are still unsure of one of your terms or concepts, it will be clarified by the instructor or a teaching assistant.

QUICK DEMONSTRATION OF PSYCHOLOGICAL FUNCTION

Purpose: A technique to illustrate how cognitive functioning can affect behavior.

Description: On two occasions the instructor will slam a book down very hard on a desk or table. One time this will be done without warning and the other it will be with a warning. The students will note the differences in their behaviors on the two occasions and try to explain those differences.

(This suggestion contributed by Dr. Merle Moskowitz.)

Learning Principle: Learning will be produced from a combination of enactive and symbolic modes.

Time Required for Use: 10 minutes

Preparation

Materials Required: A heavy book and a desk or table that will make a fairly loud noise when hit by the book.

Production Steps: None

Teaching Suggestions

1. Ask the students to read any brief section in their books or to make certain notes, so that they are not observing or thinking about the instructor. When all are concentrating, slam the book down hard. Ask them to describe their automatic responses. (Most will jump, be startled.)
2. Tell them you are going to slam the book on the table again, and have them look down at their books, while you do so. (Most will not be at all startled this time.) Ask them to describe their behaviors, and then to explain why they were not startled the second time the book was slammed down.
3. Ask what they would have done the second time the book was slammed if all learning were through conditioned responses. Lead them to see that some type of thinking, cognitive behavior, helped them control their responses on the second occasion.

FIRST-HAND CONCEPT DEVELOPMENT EXPERIENCE:

Confabulation

Purpose: A technique to provide an experience that will assure students' understanding of the term "confabulation".

Description: Students will experience confabulation when asked to list, in a limited time, ten things they did on their first day in second grade.

Learning Principle: First-hand experience provides vivid learning.

Time Required for Use: 8-10 minutes

Preparation

Materials Required: Pencils, one piece of notebook paper for each student

Production Steps: None

Teaching Suggestions

1. Ask students to spend five minutes in recalling ten things that they did on the first day of school in the second grade. Insist that each person produce ten items within the given time in order to "play the game" properly.
2. After they have completed their lists, ask them how certain they are that each item is perfectly accurate.
3. Ask how they produced the uncertain items.
4. Explain that they were confabulating when they constructed items on the basis of related experiences rather than on definite memory.

This experience can be provided with classes of any size.

MINI-EXPERIMENT TO DEMONSTRATE

A SPECIFIC CONCEPT

Purpose: To demonstrate the scientific determination of extra sensory perception.

Description: This technique introduces the students to the concept of extra-sensory perception (E.S.P.) through a mini experiment, followed by group discussion. Two identical sets of symbols are provided. The students attempt to use extra sensory perception to select which symbol the instructor or another student is holding.

Learning Principle: First-hand experience enhances the understanding of a concept.

Time Required for Use: 15 minutes

Preparation

Materials Required: Ten index cards (4"x6"); pencils, felt tipped pens; pencils

Production Steps: 1) On each of the ten index cards, draw a symbol e.g., a cross, a target, an apple, a circle, a star, a bird, a crab, a duck, a rectangle, a square, a line, an arrow, a tree.

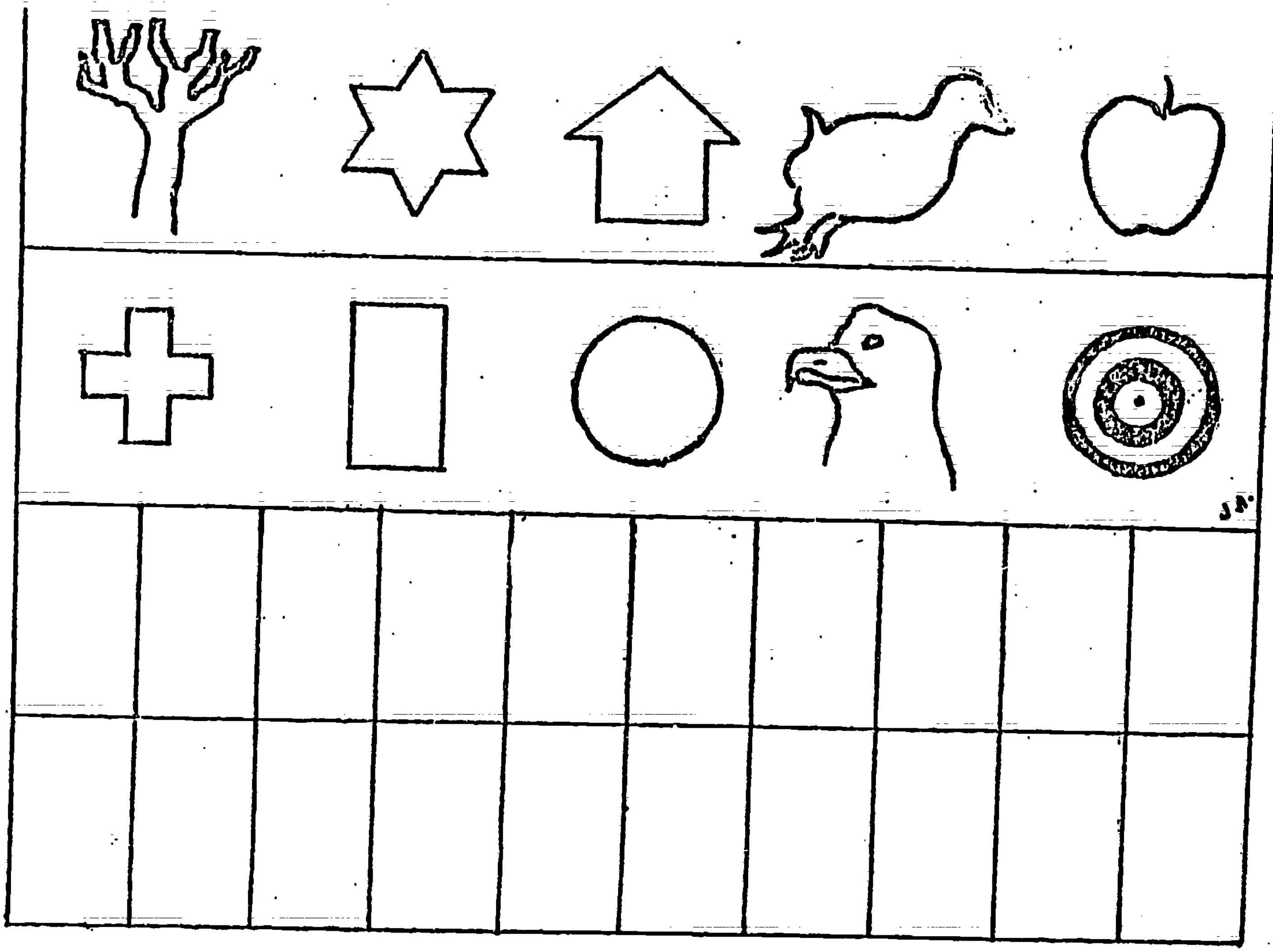
2) Draw these ten symbols also on a work sheet. Provide spaces for twenty responses on the bottom of the work sheet.

Teaching Suggestions

1) Distribute the worksheets containing the symbols to each of the students in the class.
2) Shuffle your symbol cards and pick one. As you concentrate on the card you are holding, ask the students to write down in the spaces provided on the work sheet which symbol they think is on that particular card.
3) Follow the above procedure until ten trials have been completed. Have an observer read the correct responses to the students and determine the proportion of accuracy for each.
4) Then, go on to discuss the underlying concepts of E.S.P.

The technique can be used with a group of approximately 20-50 students. You can use a regular deck of cards instead of special cards if you wish.

(See illustrations on the next two pages.)



TRANSPARENCY PYRAMID ILLUSTRATING A DEVELOPMENTAL PROCESS: Schema Attainment

Purpose: A device to develop understanding of the behavior processing theory of how schemata develop through successive experiences that result in accommodation of earlier schemata and continuing development of schemata of increasing complexity.

Description: Ten transparencies based on a circular pattern of identical outside dimensions. To illustrate development of a schema on "governmental operations", successive transparencies on family, school, city, state and national governmental experiences fit over old schema and are assimilated for the accommodation of a more complex schema.

Learning Principle: Visual symbolic experiences enhance concepts gained through auditory verbal experiences.

Time Required for Use: 10-15 minutes

Preparation

Materials Required: Drawing paper, compass, protractor, ten Thermofax transparencies

Production Steps: 1) On ten sheets of paper draw a small interior circle to represent government and a large outer circle to represent population.

2) On five drawings place arrows and rectangles showing demands of population on government at the five levels and others showing governmental responses and requirements.

3) On the other five draw circles and arrows illustrating growth of the schema.

4) Thermofax the ten transparencies.

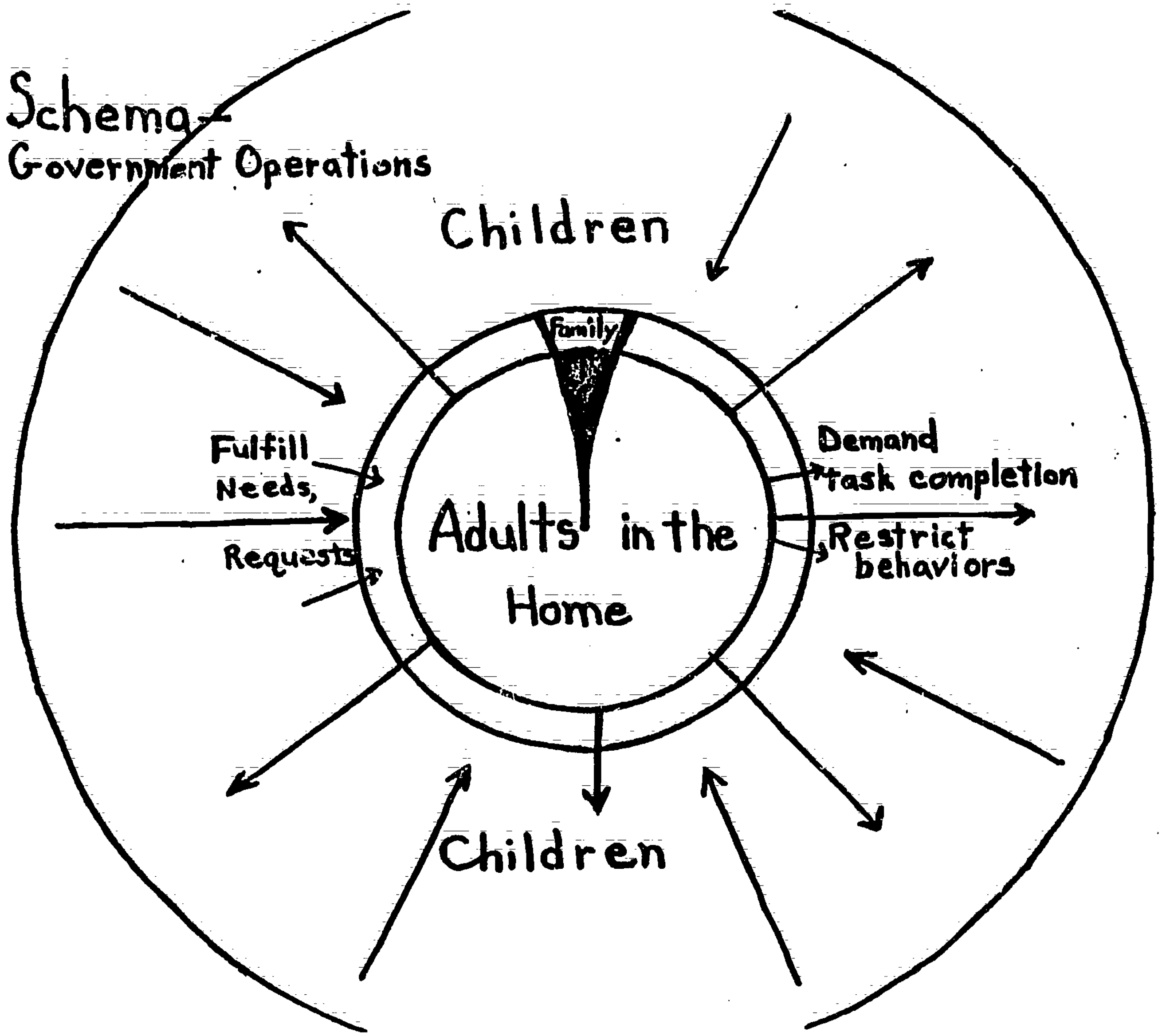
5) Hinge school experience transparency over family schema, city experiences over school schema, state experiences over city schema, and national experiences over state schema.

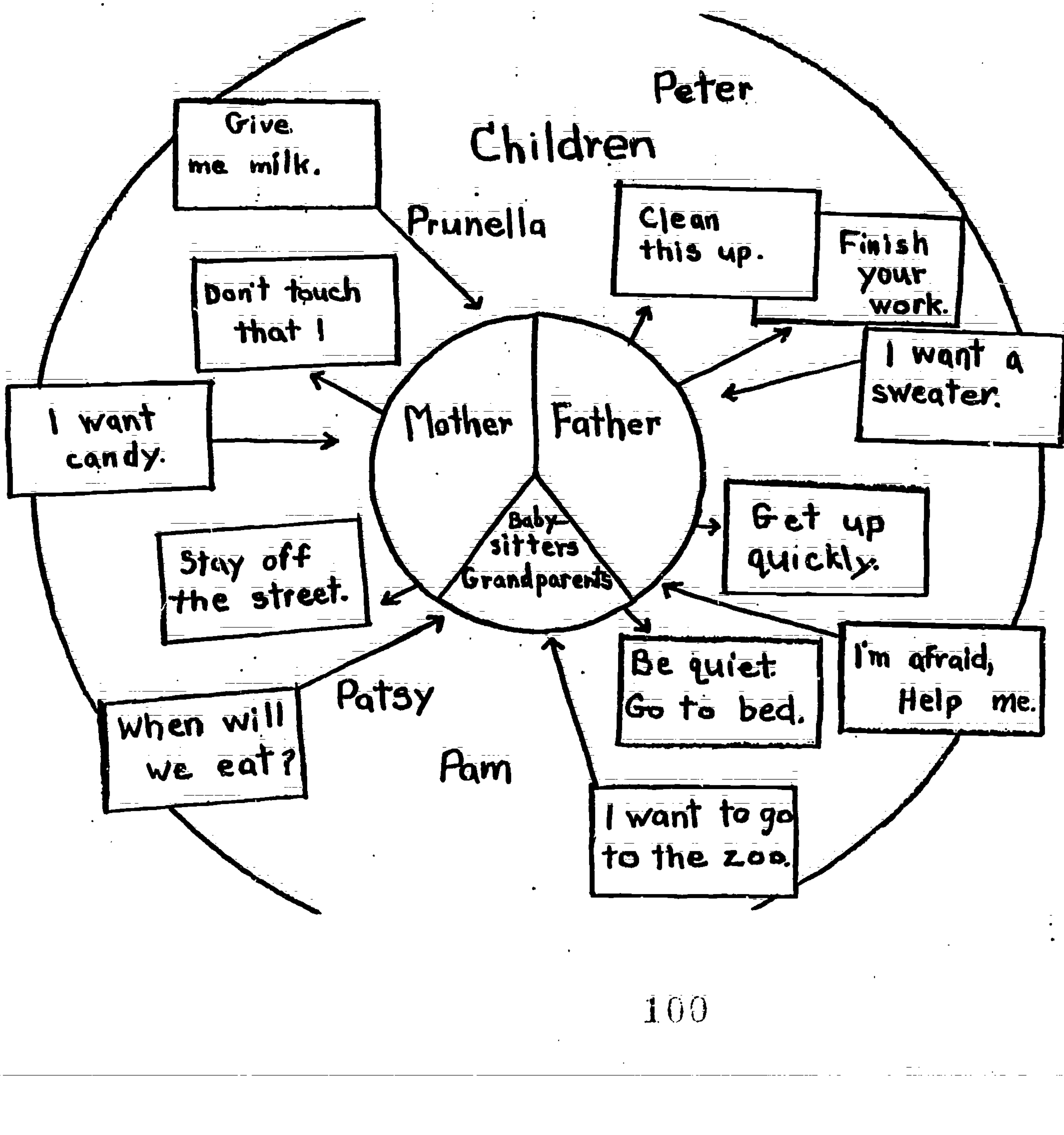
Teaching Suggestions

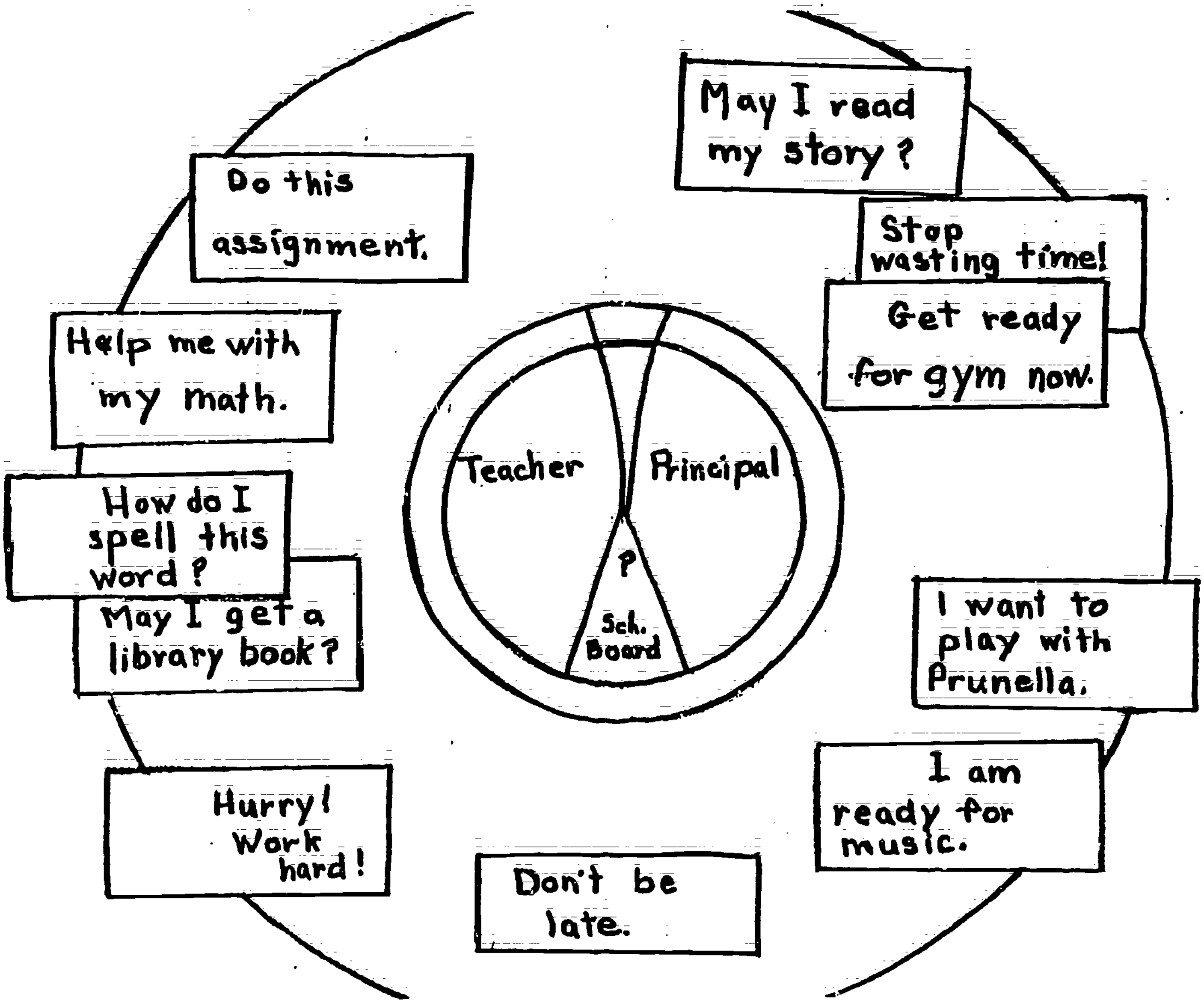
Project on large screen for large classes.

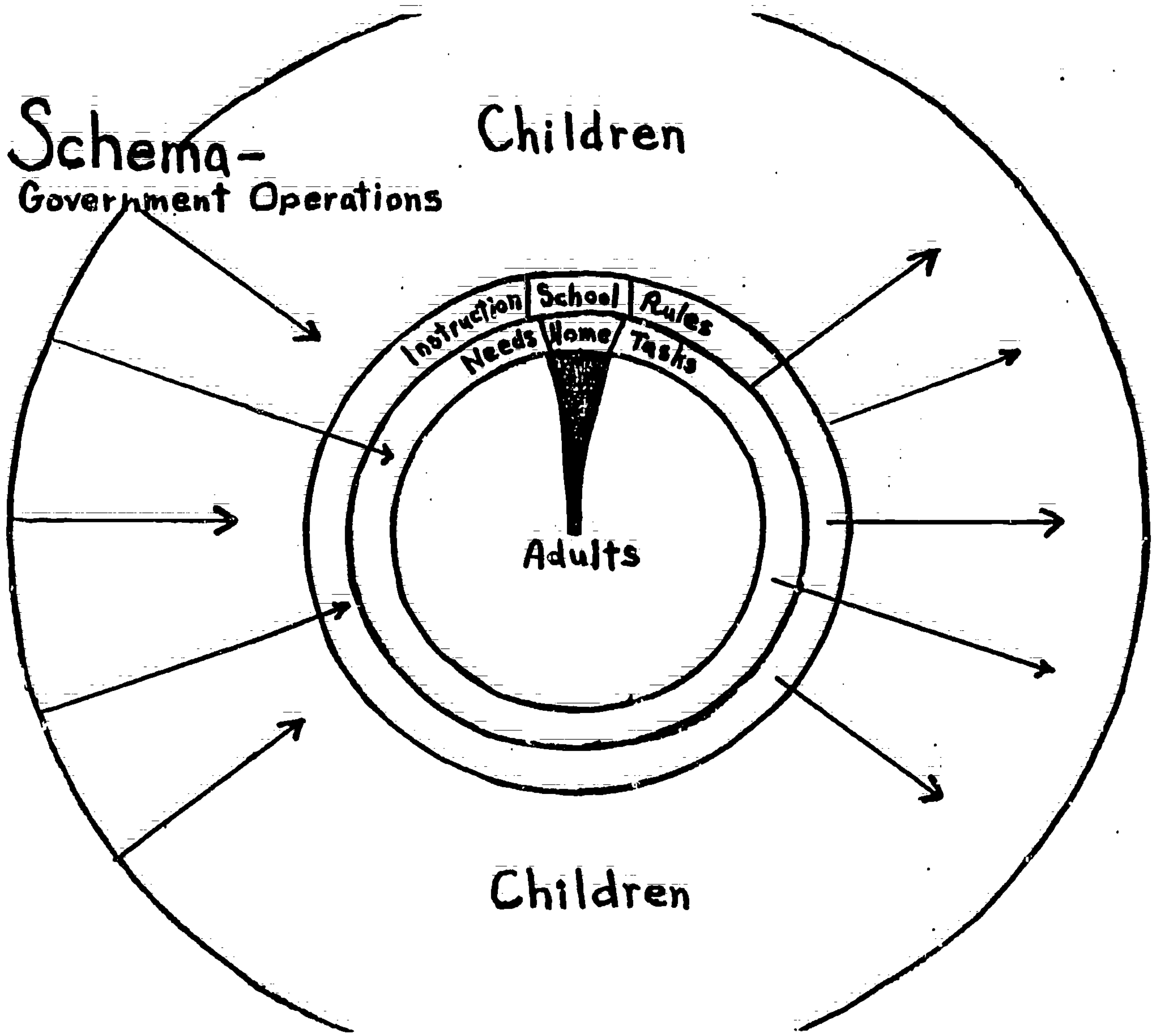
Steps:

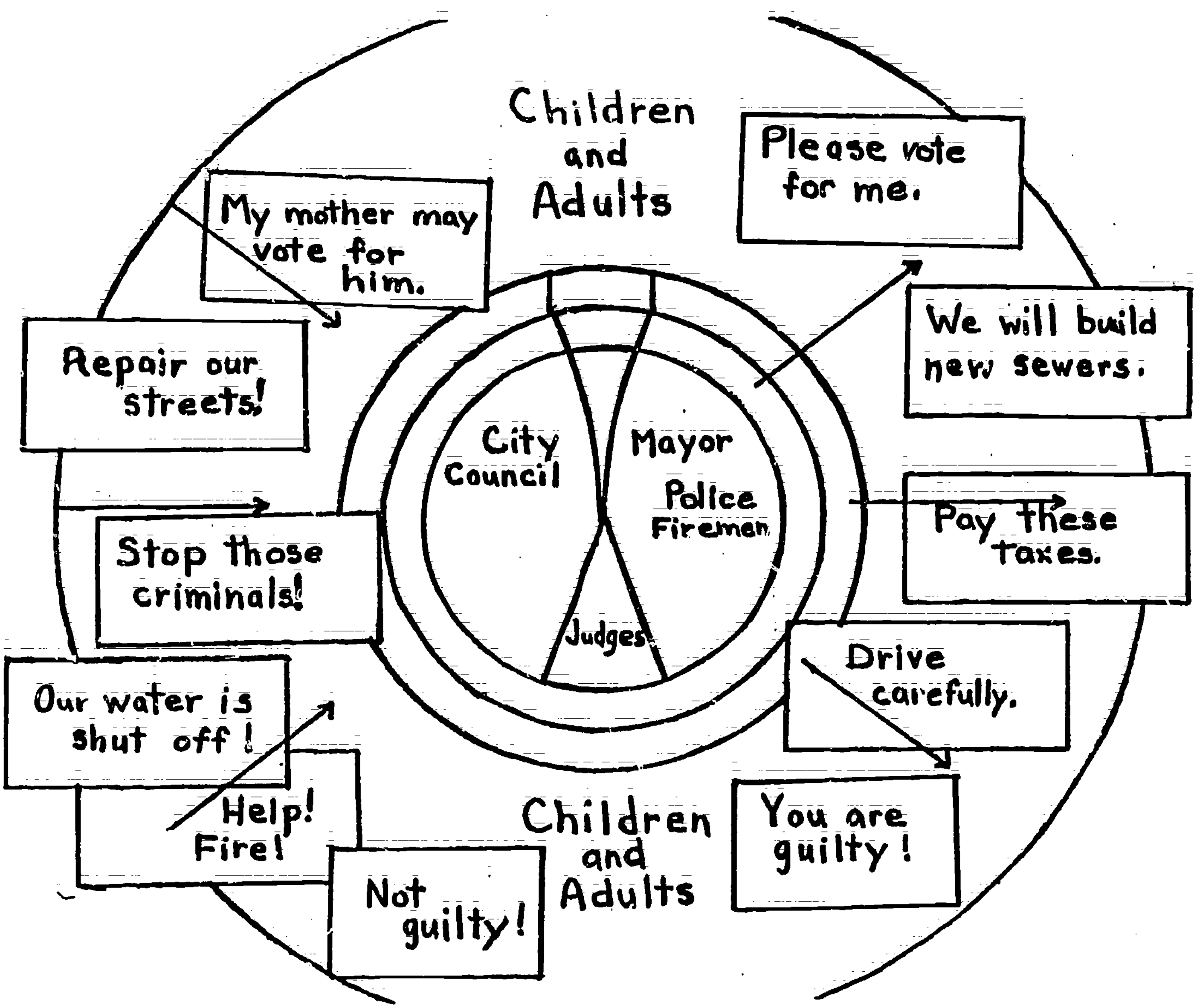
1. Project transparency showing family governmental operation; explain child demands, parent responses.
2. Project and explain schema of family governmental operations that grows from family experience.
3. Fit school experience transparency over family schema; explain how children try to assimilate new experiences to old schema.
4. Project the new school governmental operations schema and explain how school experiences are accommodated by formation of this schema.
5. Fit city experience transparency on school schema and explain as in step 3.
6. Continue to develop schema in same style with other transparencies.
7. With Transparency No. 10 explain that the schema is now much more complex; also any schema is connected to many related schemata as shown by overlapping circles.


Schema-
Government Operations
Children
Family
Fulfill
Needs,
Requests
Adults in the
Home
Demand
task completion
Restrict
behaviors
Children

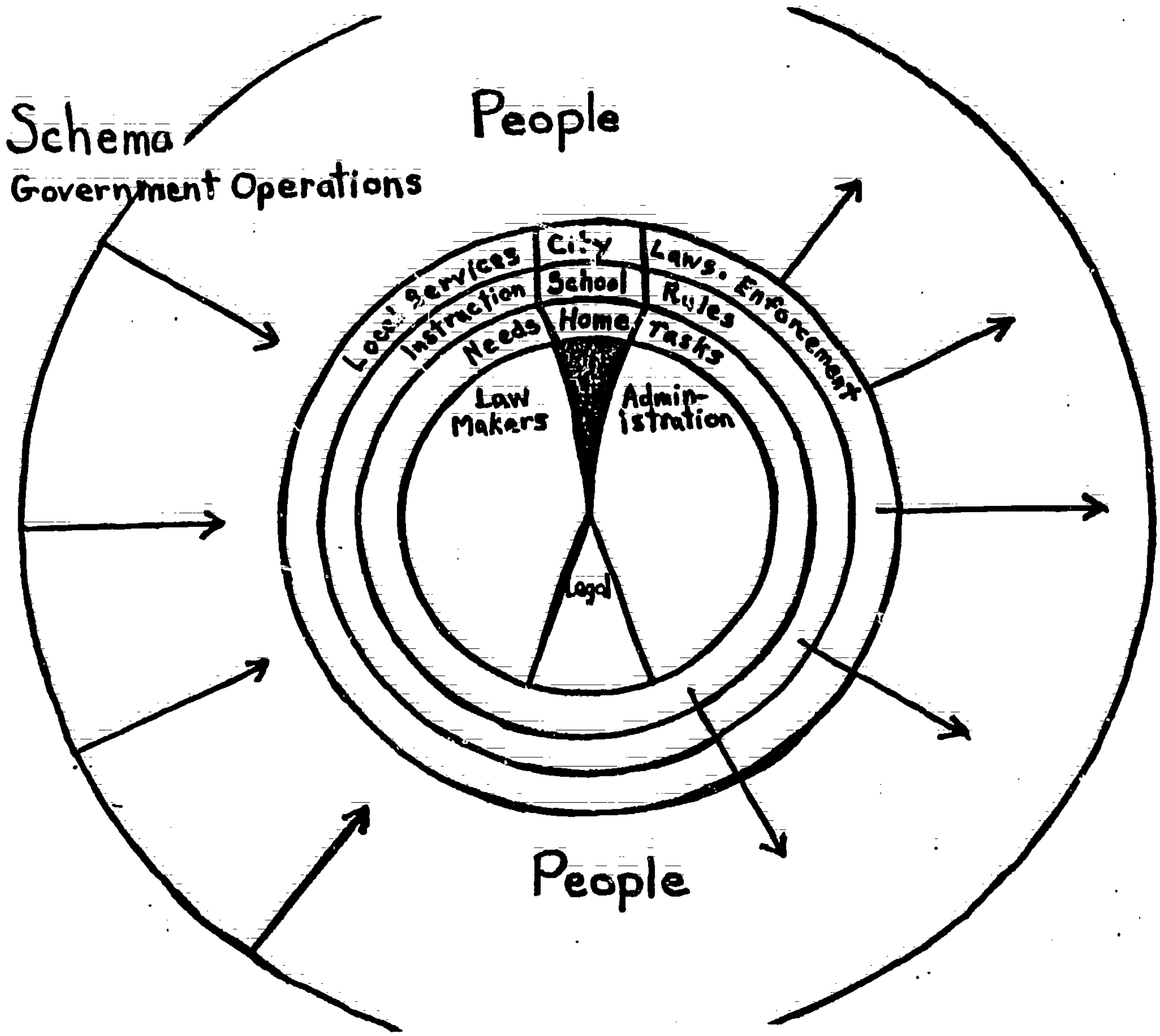

Children
Peter
Prunella
Patsy
Pam
Mother
Father
Baby-sitters
Grandparents
Give me milk.
Don't touch that!
I want candy.
Stay off the street.
When will we eat?
Clean this up.
Finish your work.
I want a sweater.
Get up quickly.
Be quiet. Go to bed.
I'm afraid, Help me.
I want to go to the zoo.


May I read my story ?
Do this assignment.
Stop wasting time!
Get ready for gym now.
Help me with my math.
Teacher
Principal
?
Sch. Board
How do I spell this word ?
May I get a library book ?
I want to play with Prunella.
I am ready for music.
Hurry! Work hard!
Don't be late.

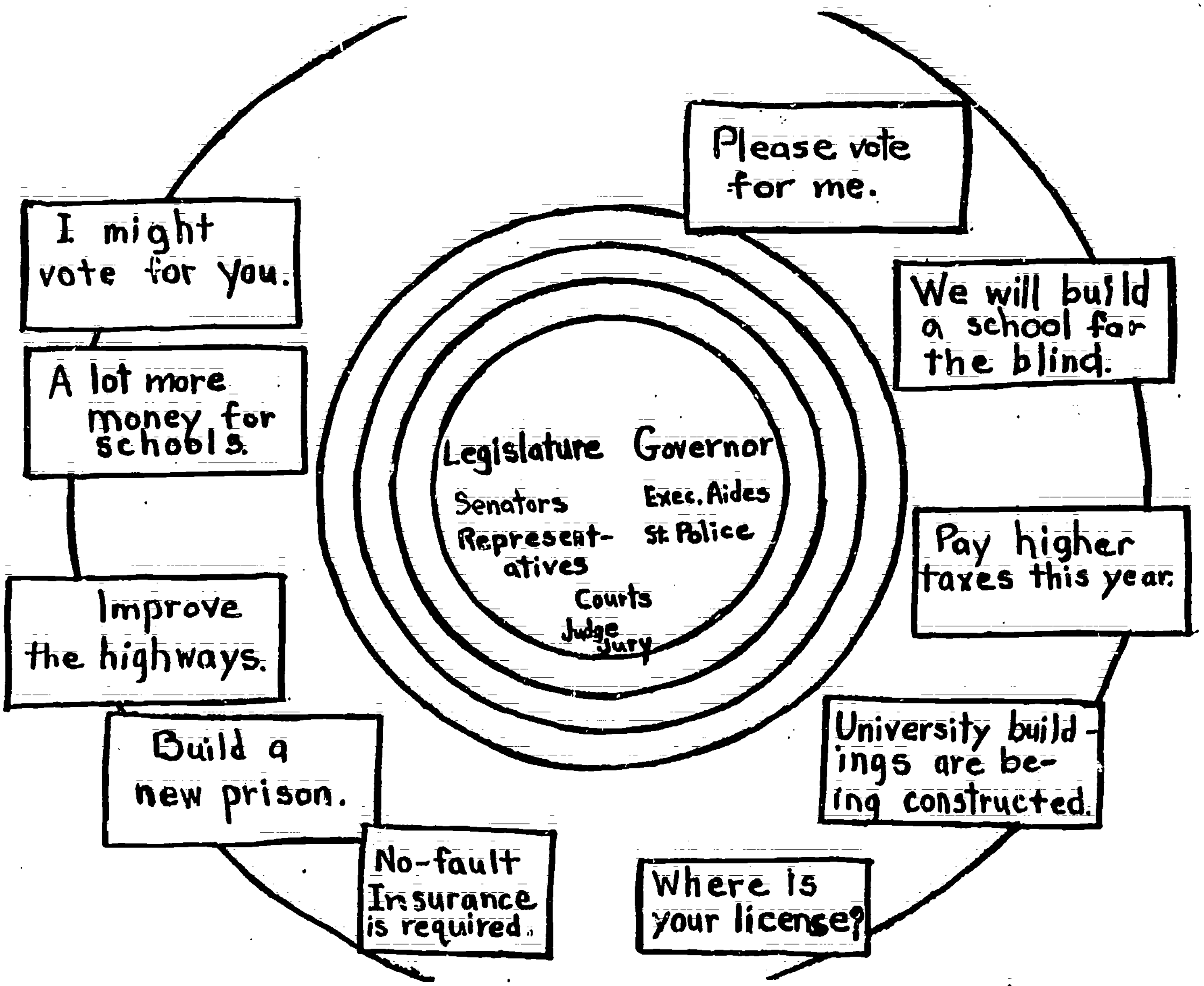

Schema-
Government Operations
Children
Instruction
School
Rules
Needs
Home
Tasks
Adults
Children

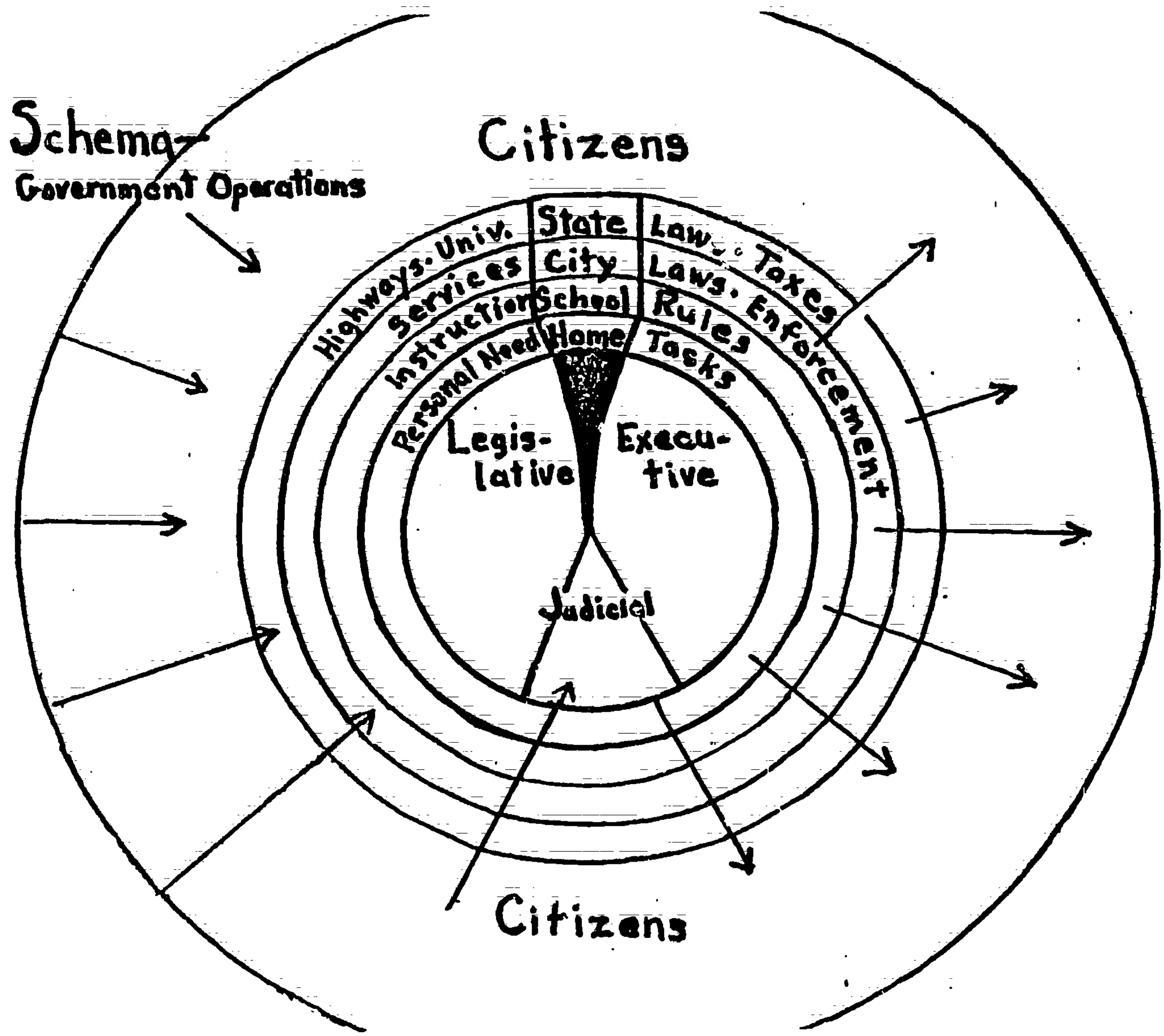


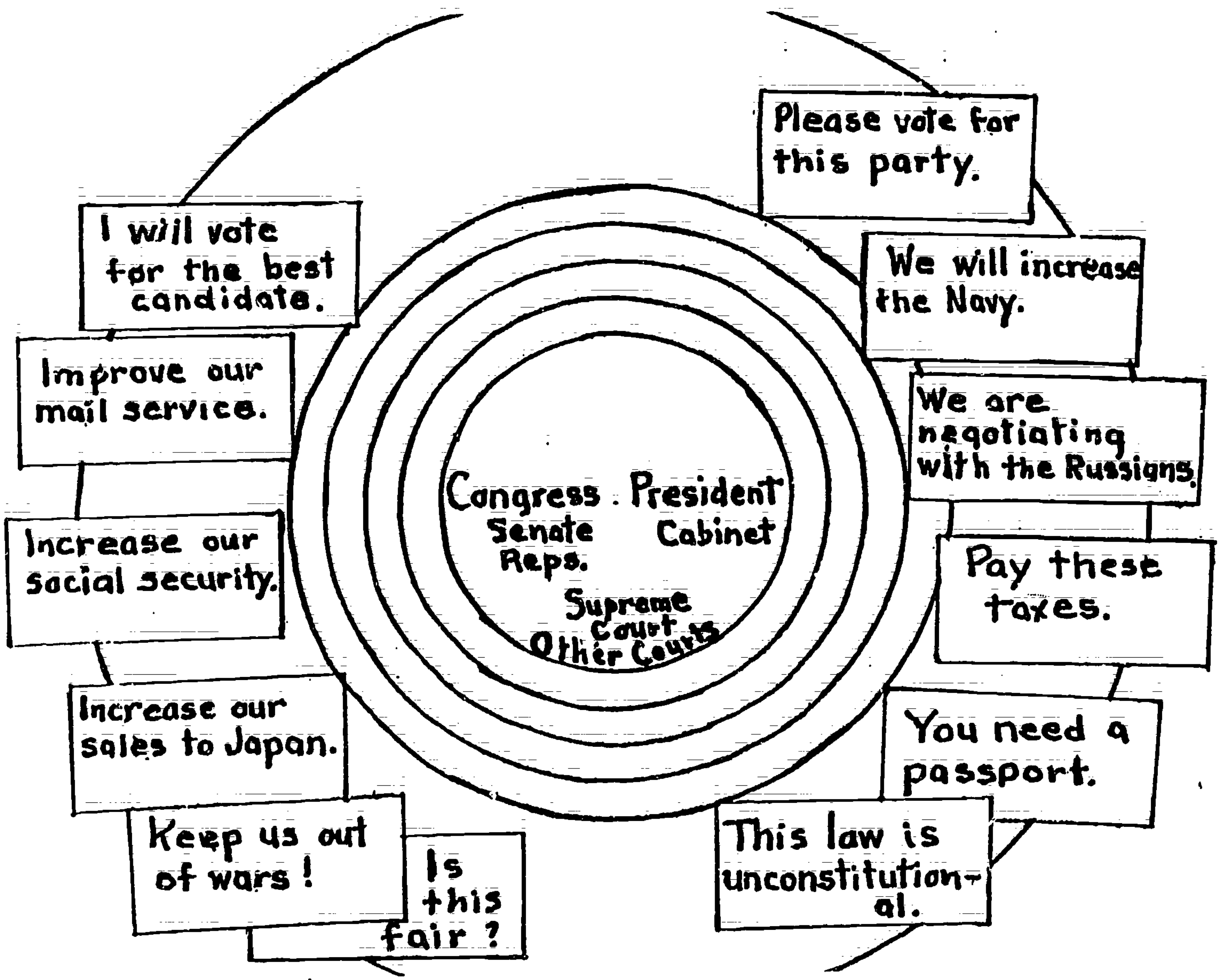
Children and Adults
Please vote for me.
My mother may vote for him.
We will build new sewers.
Repair our streets!
City Council
Mayor
Police Fireman
Judges
Pay these taxes.
Stop those criminals!
Drive carefully.
Our water is shut off!
Help! Fire!
Children and Adults
You are guilty!
Not guilty!

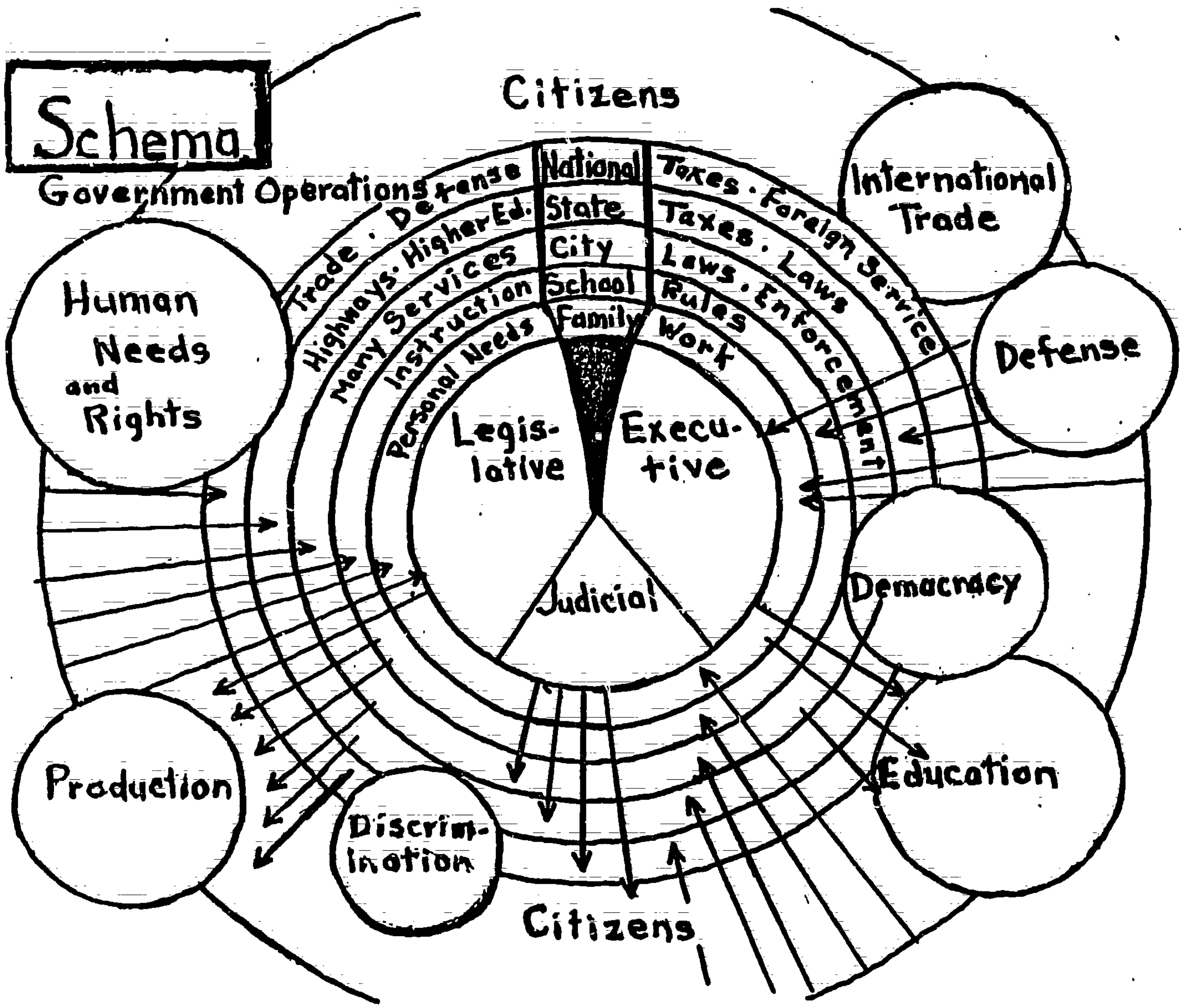

Schema
Government Operations
People
City
School
Home
Local Services
Instruction
Needs
Laws. Enforcement
Rules
Tasks
Law Makers
Admin-istration
Legal
People

68


Please vote for me.
We will build a school for the blind.
Pay higher taxes this year.
University buildings are being constructed.
Where is your license?
No-fault Insurance is required.
Build a new prison.
Improve the highways.
A lot more money for schools.
I might vote for you.
Legislature
Senators
Representatives
Governor
Exec. Aides
St. Police
Courts
Judge
Jury


Schema—
Government Operations
Citizens
State
City
School
Home
Highways. Univ.
Services
Instruction
Personal Need
Laws. Taxes
Laws. Enforcement
Rules
Tasks
Legis-
lative
Execu-
tive
Judicial
Citizens


Please vote for this party.
We will increase the Navy.
We are negotiating with the Russians.
Pay these taxes.
You need a passport.
This law is unconstitution-al.
I will vote for the best candidate.
Improve our mail service.
Increase our social security.
Increase our sales to Japan.
Keep us out of wars!
Is this fair?
Congress
Senate
Reps.
President
Cabinet
Supreme Court &
Other Courts



Schema
Government Operations
Citizens
National
State
City
School
Family
Trade · Defense
Highways · Higher Ed.
Many Services
Instruction
Personal Needs
Taxes · Foreign Service
Taxes · Laws
Laws · Enforcement
Rules
Work
Legis-
lative
Execu-
tive
Judicial
Human
Needs
and
Rights
International
Trade
Defense
Democracy
Education
Production
Discrim-
ination
Citizens

CONTRASTING EXPERIENCES TO CLARIFY PROCESSES:

Inductive and Deductive Reasoning

Purpose: A technique for using first-hand verbal experiences to develop an understanding of inductive reasoning and deductive reasoning. Further explanation of abductive reasoning is provided.

Description: The students will be led to discover inductively that changing the normal stress on words in an English sentence will add new meaning. Then they will engage in deductive reasoning to produce a weather prediction based on past knowledge of the effects of winds and cloud conditions on the weather. An explanation of abductive reasoning will be added if time permits.

Learning Principle: Direct experience produces learning if the experience is followed by discussion.

Time Required for Use: 18-20 minutes

Preparation

Materials Required: A list of sentences to be used in the inductive reasoning step.

Production Steps: List the sentences to be used as examples.

Teaching Suggestions

This technique will be most effective with small groups, but it can be used as a demonstration with a few students in front of a large class.

Suggested instructional steps:

1. Read aloud those sentences on the chalkboard, and notice which word carries the heaviest stress.

    a. Jim's mother carefully baked several fish.
    b. Mary quickly fried the chicken in a large pan.
    c. Joe completely filled the red basket with fruit.

    On which word in every sentence do you place the heaviest stress? (Normally on the last word in English sentences.)

2. Now read the sentence with the heaviest stress on "mother."

    Jim's mother carefully baked several fish.

    What meaning is added to this sentence that was not apparent in the first? (It eliminated Jim's wife, father, sister, brother, or any other family member as the cook.)

3. Now read the sentence stressing "baked."

   Jim's mother carefully <u>baked</u> several fish.

   What new information do we have now? (It implies that she considered frying or broiling, but decided on baking.)

4. (Continue similar process with other sentences.)

5. What have you learned from this experience? (That change the heaviest stress on words in English sentences adds new implications, or meanings.)

6. You learned this through a process called inductive thinking, or inductive reasoning. What were the major steps? What is inductive thinking? (We began with a number of specific experiences and progressed toward a generalization. Inductive thinking is the abstraction of principles, generalizations, or conclusions from a set of observations and instances.)

7. Now let's try a different type of reasoning. Instead of beginning with a set of observations, we will begin with a statement of some previously known "factual" generalization, a "proposition." For example, "When the sky is laden with low, cumulous clouds, we always have rain." What are the cloud conditions today? Make a statement. (Today our sky is laden with low, cumulous clouds.) After these two statements, what must logically follow? (We are going to have rain today.)

8. This is an example of deductive reasoning. Let's state several beginning propositions related to everyday life, and see how we can reason to conclusions. For example:

   Students who do not study receive low grades.
   John does not study. John will receive a low grade.

   Houseplants must have plenty of sunlight in order to survive.
   My houseplants are not near a window or any other light source. They are not going to survive.

9. What are the basic differences between inductive and deductive reasoning? (In inductive reasoning we start with observations of several examples of a circumstance and abstract a generalized truth. With deductive reasoning we start with a proposition that is supposed to be true, consider a circumstance involving that proposition, and make a conclusion. Inductive leads to new knowledge; deductive reasoning leads from one fact to another.)

SELF-TESTING TECHNIQUE TO FOSTER COMPREHENSION:

Metacognition

Purpose: A technique to develop the concepts of metacomprehension and metacognition while the student estimates his own metacomprehension.

Description: The students are provided with a two-page selection (perhaps from a textbook) and are given a limited amount of time to learn the major concepts and principles from the pages. Then they are asked to make a note of the amount of this material that they understood, giving both a percentage estimate and a proportional estimate on a continuum. They then take a short test on the material, check their tests, and compare the results with their percentage estimates of comprehension. Discussion follows.

Learning Principle: Guided discovery provides learning that is more meaningful than does mere verbal transmission of information.

Time Required for Use: 20 minutes

Preparation

Materials Required:
1. A two-page selection from a chapter that comes later in the textbook.
2. Duplicating paper and stencils

Production Steps:
1. Duplicate the selection or plan to have students read from their texts.
2. Prepare a 10-point test on the selection.
3. Prepare a response sheet on which students can enter their metacognition estimates and their answers for the 10-point test.

Teaching Suggestions

This technique can be used with groups of any size. The steps are:
1. Ask the students to read the selection and try to learn its main and supporting ideas in a limited time, 8 or 10 minutes.
2. Give them the response sheet and ask them to estimate the amount they comprehended and retained from the brief study; they should enter both the proportional and percentages estimates.
3. Administer the short test.
4. Have students check their own answers as you give the correct responses. (Assure them this is not to be graded.)
5. Have them enter on the response sheets their percentages of accuracy and compare with their estimates. Consider proportional estimates if they think some test item included much more than others.
6. Explain that they have checked their own metacomprehension, which is closely related to metacognition, "the ability to monitor one's own thoughts." (Wortman and Loftus, 1981)

(See illustrative materials on the next five pages.)

AN EXPERIENCE WITH METACOMPREHENSION (METACOGNITION)

Read this selection and try to learn its content in the limited period of time given. Then follow the directions of the instructor.

REQUIREMENTS OF A TEST

In essence, a psychological test is an objective, standardized measure of a sample of a person's behavior. The value of a test depends on the extent to which it serves as an indicator of some significant area of behavior. For example, a job applicant may be asked to work a series of mechanical puzzles as a test of problem-solving ability on the job. The applicant's score on these puzzles, in and of itself, is not of much interest or importance. But if it is possible to demonstrate that there is a close correspondence between the applicant's score and subsequent job performance, then the test is serving as an indicator of an important aspect of behavior.

Suppose a child gets a score of 88 on a test of general intelligence. How good is this test? Is it good enough to justify assigning the student to a "slow" track in school? In order to answer these questions, we would have to obtain information about the **reliability** and the **validity** of the test in question. We would also want information about whether the test had been **standardized**—that is, whether norms have been developed indicating how other students have performed. These three concepts—reliability, validity, and standardization—are discussed in detail in the following sections.

Reliability

An assessment technique or a test is reliable if it consistently yields the same results. If a child received a score of 115 on an intelligence test administered on Monday and a score of 88 on one administered on Tuesday, we would have cause for concern about the test's reliability. The top portion of Figure 14.1 shows a pattern of scores for a highly reliable test, while the bottom portion shows a pattern of scores for an unreliable test.

Before a test or an assessment technique is adopted it is important for the developers of the test to demonstrate its reliability. Several kinds of reliability might be assessed. One is test-retest reliability, which can be determined by administering the same test to the same person on more than one occasion. If a child takes the same intelligence test on two consecutive days, we would expect the scores to be similar if the test is reliable. If test-retest reliability is high, we gain confidence that the test scores are not highly susceptible to fluctuating conditions of the subject (such as fatigue or nervousness), or to the testing environment.

One problem with test-retest reliability is that even though a given person's retest yields a score highly similar to the score on the original test, this similarity does not necessarily mean that the test is reliable. If the interval between tests is fairly short, the student may simply recall many of his or her former answers; the test may thus appear more reliable than it really is. For this reason, psychologists have devised other methods to assess reliability. One such method is the use of alternative forms of a test. Ideally, the tests should include different items, but otherwise be comparable in length, difficulty, and so on. A person can be tested with one form on one occasion and with a comparable form on the second occasion. For example, suppose we are interested in the effects of a new orientation program on the self-esteem of college freshmen. Alternative forms of a self-esteem test, assuming that the test is reliable, can be used to assess the impact of our program. Subjects can be given one form of the test prior to and a second form after the orientation.

It takes a great deal of effort and pilot testing to create alternative forms of a test that are truly equivalent. For this reason, alternative forms have not been developed for many assessment procedures. Another problem with alternative forms, as well as with test-retest reliability, is that it is not always possible to administer a second test. Suppose we are interested in assessing the emotional reactions of hospitalized patients prior to surgery—by administering a mood scale with twenty items on anger, twenty on depression, and twenty on anxiety—and correlating the reactions with later recovery. Hospital personnel may insist that patients be interviewed only once prior to surgery. A type of reliability that can be calculated in this setting is called *split-half reliability*. The items making up a particular scale (for example, that of anger) can be randomly divided in half and the subject's score on one set of items can be related to his or her score on the second set. This measure of reliability is sometimes called *internal consistency*. A test is internally consistent if a given subject responds in the same way to items that are supposed to be measuring the same thing. Of course, many tests are designed to measure more than one thing. If the SAT were internally consistent, we would expect a subject's verbal score on half of the items to be similar to his or her score on the other half. We would *not* expect the score on the verbal items to be highly similar to the score on the math items, since the two parts of the SAT are designed to measure different abilities.

As we will see in the sections that follow, some assessment techniques are completed by the subject and are objectively scored, while in others, the subject's behavior or test responses are interpreted by other people. For example, on the assessment tool called the Rorschach, subjects are required to comment on a series of inkblots, and trained clinicians interpret the subject's responses. In tests that involve judgments of this type, *interjudge reliability* is important. We would want to have evidence that two people who had been trained in interpreting the Rorschach would independently make similar judgments if asked to interpret the same responses.

While it is important for an investigator to demonstrate that a test is reliable, the type of reliability that is most appropriate depends on the type of test and on the stability of the trait or attribute being measured. If we are measuring intelligence, for example, we would expect this construct to remain stable over time, and so could examine test-retest reliability or alternative forms reliability. But if we are interested in assessing mood, test-retest reliability would not be very informative because we would expect mood to fluctuate over time. Thus, we might use a split-half technique in assessing the reliability of a mood scale.

From Wortman, Camille B.; Loftus, Elisabeth F., and Marshall, Mary. Psychology. New York: Alfred A. Knopf, 1981, pages 438-440.

METACOMPREHENSION CHECK-TEST

Respond on the answer sheet provided. Select the right letters for responses to the numbered items. Some responses may be used more than once.

1. An objective, standardized measure of a sample of a person's behavior is called a ________________.

2. A test is ______________ if it yields the same score for a student under varying conditions.

3. Zack scored 105 points on a test on Friday, and on an equivalent test he scored 88 points on Monday. This test would be considered __________.

4. The amount that a student learns when first taking a test may be a problem when using ________________.

5. According to the text, the problem in Item 4 is offset best by developing reliability coefficients based on use of ________________.

6. The internal consistency of a test is determined when one computes the ______________.

7. When test responses are expected to be fairly subjective, the test maker would prefer to compute __________.

8. In assessing the reliability of a measure of mood, the <u>least</u> appropriate coefficient would be ______________.

9. The most time-consuming method for determining reliability is the one based on ________________.

10. To obtain high reliability on a test, one must measure a characteristic that is relatively ________________.

<u>Possible Responses</u>

a. unreliable

b. perception test

c. valid

d. split-half reliability

e. standardized

f. reliable

g. psychological test

h. intelligence test

i. stable

j. self-esteem test

k. alternate forms

l. multiple copies

m. test-retest reliability

n. interjudge reliability

NAME ______________________

DATE ______________________

METACOMPREHENSION ESTIMATION

I. Estimating your comprehension and learning
How thoroughly do you feel you understood and learned this selection? Make a check on the scale line below to indicate the completeness of your understanding.

Little Learned	1	2	3	4	5	6	7	8	9	10	Completely Learned

If this were a quantitative estimate, what percentage of the content do you feel you learned? Write your estimate in the box, please.

[%]

II. Testing your Comprehension and Learning
(Match letters of responses with numbered questions.)

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Number correct ______

Percentage correct ______

Key

Metacomprehension Check-test

1. g- psychological test
2. f- reliable
3. a- unreliable
4. m- test-retest reliability
5. k- alternate forms
6. d- split-half reliability
7. n- interjudge reliability
8. m- test-retest reliability
9. k- alternate forms
10. i- stable

RECORDED COMPARISON:

Linguistic Competence vs. Linguistic Performance

Purpose: A technique to clarify the meanings of "linguistic competence", and "linguistic performance".

Description: Students will record on tape or in writing examples of their usual linguistic performances, then will compare these with examples of the most complex sentences they can construct.

Learning Principle: Examples enhance understanding.

Time Required for Use: 15-18 minutes

Preparation

Materials Required: Tape recorder, Examples of a couple of very complex sentences

Production Steps: None required.

Teaching Suggestions

Can be used with small groups, or with a large class that is temporarily subgrouped.
Steps:

1. Ask class to think through their reaction to a topic of current interest, such as the success or failure of a local athletic team, or something of interest in the course.
2. Have each record his/her comments briefly on tape or in writing.
3. Have them listen to the comments of other members of their group and make observations about average sentence lengths and sentence complexity.
4. Ask each now to record the most complex sentence that he/she can construct on the topic discussed. Give a couple of examples of sentence complexity, such as:

   "Although the president of the United States, who is said to have the most powerful position in the world, has gone on record as opposing Soviet intervention in Nicaragua, where a long civil war has followed the Sandanista take-over from Somosa, he has agreed to consider increasing trade with the Russians, while at the same time trying to prevent Cuba from increasing its efforts to spread communism in Central and South American countries."

   (or)
   "Having had a bad season last year, and having traded away some of their best veteran players while retaining other old campaigners, the Pittsburgh Pirates may have difficulty in proving that they are real contenders next year, even though they have good young players coming up from their farm teams, and even though they fortunately have been winning fairly consistently in the preseason demonstration games that are in progress in the balmy Florida weather."

5. Students will write or record their sentences on tape, then share them.
6. Discussion:

   Why were your later sentences so much longer and more complex than your earlier sentences? (Answer: In everyday conversation, we usually do not use the most complex language that we are capable of using.)

   Which sentences represent your "linguistic performance"?

   Which comes closer to representing your "linguistic competence"?

   Although the complex sentences probably do not indicate the full extent of the student's linguistic competence, they help to clarify the fact that each person has linguistic competence that is not always revealed.

FOLDING CHART:

DEEP STRUCTURE/SURFACE STRUCTURE

Purpose: A device to clarify the meaning of "deep structure" and "surface structure" in the processing of language.

Description: This chart consists of a center section approximately fourteen inches wide, and two side flaps that are approximately seven inches wide each. The center section is approximately 22 inches tall, but the top parts of the side flaps are cut down so that they are five inches shorter. The higher top part of the middle section bears the title "Transforming Deep Structures to Surface Structures", and a complete sentence is written on the front of the chart when the flaps are closed. When the flaps are open, the chart shows on the students' left an outline drawing of a person's head containing the underlying, deep structures (propositions) included in the original sentence. On the left side there is a list of many ways in which those propositions could be transformed into sentences (surface structures).

Learning Principle: An experience in the semi-iconic mode can enhance learning beyond what occurs through the purely symbolic.

Time Required for Use: 10 minutes

Preparation

Materials Required: One large sheet of colored tagboard, and felt lettering pens of three colors.

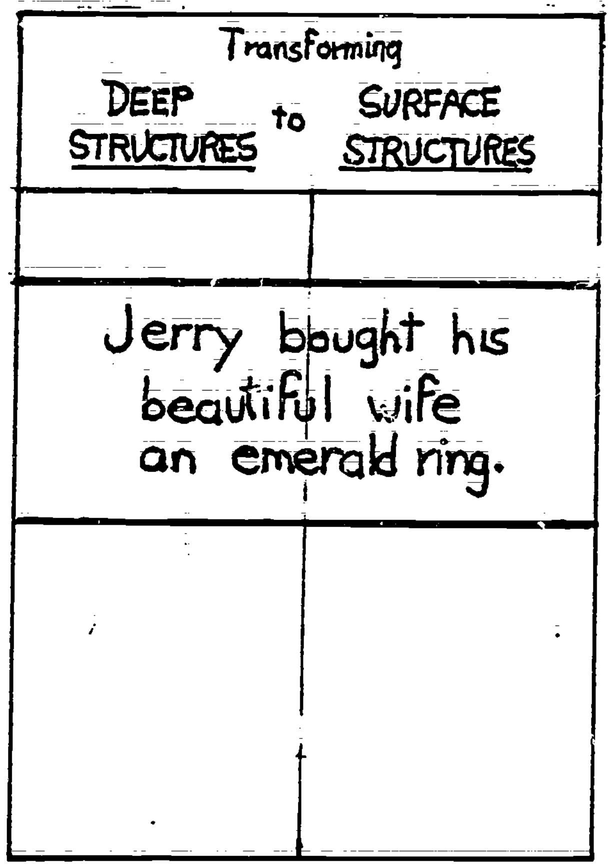
Production Steps: Make the chart as described above, using different colors for the initial sentence, for the deep structure statements, and for the surface structure statements. The chart can be made larger for a very large class.

Teaching Suggestions

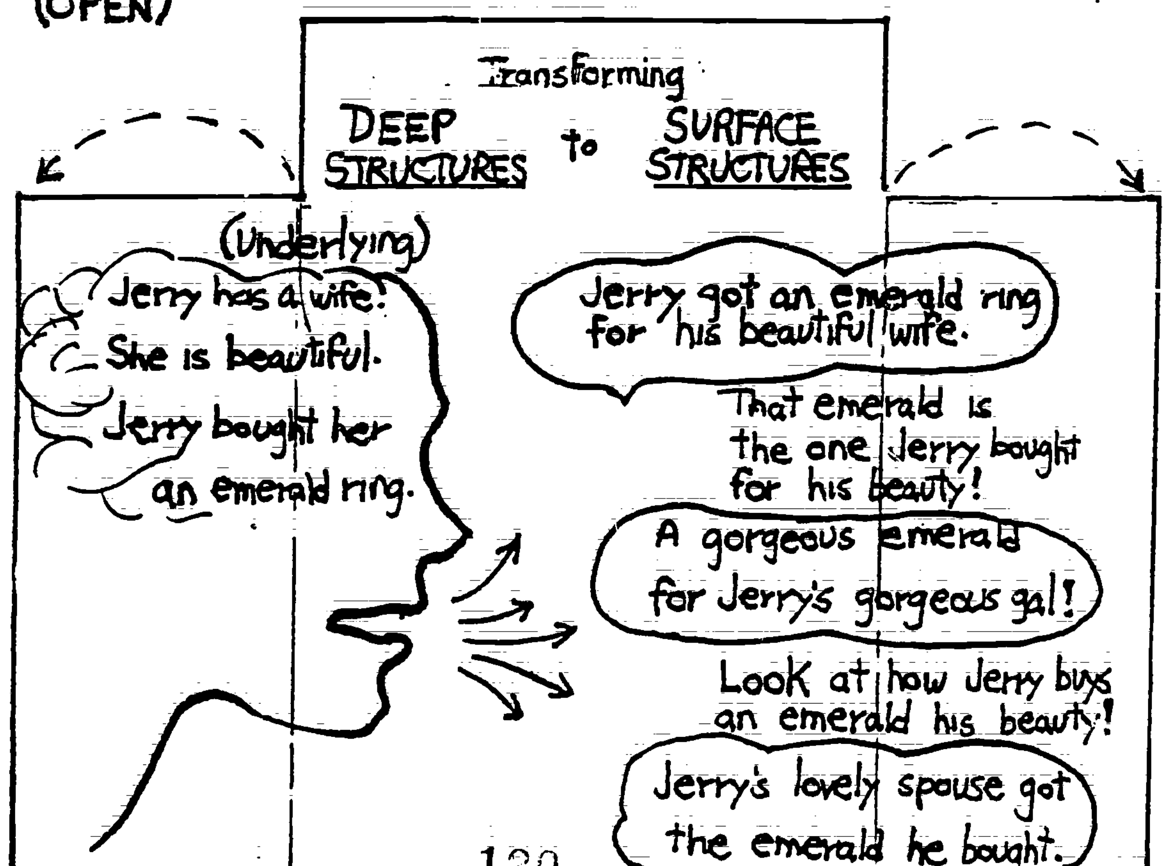
This chart can be used to help students conceptualize the statements made in the text and in the lectures about language transformation for deep to surface structure. Begin by showing the sentence on the closed flaps. Ask students if they understand this to be a deep or surface structure. Open the flap on the students' left, to show the deep structure propositions that are the basis for the sentence. Ask them to form their own sentences that would include these propositions (in one sentence). Then open the other flap to show a number of the possible surface structures that they might have produced.

(The chart is illustrated in both open and closed form on the next page.)

(FOLDED SHUT)



(OPEN)



TRANSPARENCY SUMMARIZATION SET: Moral Development

Purpose: A device to aid students in understanding how Kohlberg's stages of moral development fit as subdivisions under Dewey's levels of moral development, while also increasing understanding of Kohlberg's theory of moral development.

Description: This device consists of a base transparency showing Dewey's three levels (preconventional, conventional, and principled), with three overlays to place two of Kohlberg's stages under each of Dewey's levels.

Learning Principle: Students learn from perceiving how details fit under a pattern of general ideas or principles.

Time Required for Use: 10-15 minutes

Preparation

Materials Required: Four transparencies with suitable writing and processing materials.

Production Steps: 1. Write or type the whole developmental outline on one sheet of paper, placing Kohlberg's Stages 1 and 2 under Dewey's Preconventional Level, etc. Give brief explanations of each level and stage as well as their titles.

2. Cut the sheet into six horizontal strips with each level on a separate strip and each pair of stages on a separate strip.

3. Mount the three strips for Levels on one sheet of white paper in exactly the same position where they occurred on the sheet before it was cut into strips.

4. Mount each of the strips for Stages on separate sheets of white paper in exactly the same position where they occurred on the original sheet before it was cut.

5. Make four transparencies of these sheets and hinge them together so that the Stages fall into place over the Levels.

Teaching Suggestions

Show and discuss the differences in the descriptions of the Levels. Then show and discuss two Stages at a time under each Level.

(See the illustration of the combined transparencies on the next page.)

LEVELS AND STAGES OF MORAL DEVELOPMENT*
Lawrence Kohlberg

Base Transparency

PRECONVENTIONAL LEVEL

Makes moral judgements on the basis of power of authority figures, rewards, avoidance of punishment, and exchanging favors.

Stage 1: Punishment & Obedience Orientation

- Thinks good and bad are determined by the physical consequences of behavior.
- Thinks of earning rewards or avoiding punishments.
- Defers to power of authority figures.

Stage 2: Instrumental Relativist Orientation

- Makes moral judgements to satisfy own needs and sometimes needs of others.
- Thinks of fairness pragmatically as a benefit to self if one is fair to somebody else.

First Overlay

Base Tr.

CONVENTIONAL LEVEL

Makes moral judgements on the basis of conforming to accepted social conventions: values living up to the expectations of family, social group, or the nation regardless of the consequences; shows loyalty to the social order and actively supports it.

Stage 3: Interpersonal Sharing Orientation

- Equates good behavior with whatever pleases others—what others approve.
- Often conforms to stereotypical patterns of group behavior.
- Earns approval by being "nice," and judges behavior by one's intentions.

Stage 4: Societal Maintenance Orientation

- Judges behavior by authority, fixed rules and maintaining of the social order.
- Thinks that right behavior is doing one's duty, respecting authority, and maintaining the social order for its own sake.

Second Overlay

Base

PRINCIPLED LEVEL

Reasons according to moral principles that have validity apart from the authority of membership groups.

Stage 5: Social Contact, Human Rights and Welfare Orientation

- Does not accept authority unquestioningly.
- Tends to determine right action in terms of general individual rights and standards critically examined by society and agreed upon in major public documents.
- Thinks in terms of legal points, but emphasizes the possibility of well considered changes in laws suitable for the welfare of society.
- Feels free agreements and contracts can bind people where no laws apply.

Stage 6: Universal Ethical Principles Orientation

- Thinks in terms of abstract ethical principles rather than concrete rules.
- Thinks that what is right is determined through the individual conscience based on human equality, liberty, and justice.
- Considers logical comprehensiveness, universality, and consistency of ethical principles.

Third Overlay

*Moral Development is the gradual attainment of a sense of right and wrong.

EXPANDING CHART:
Maslow's Hierarchy

Purpose: A device to explain how individuals develop to higher levels of motivation as their needs are fulfilled at lower levels.

Description: This is a pyramidal chart in four sections. The lower section is a base showing the title and the basic principle involved. The next section above the base shows pictures and captions illustrating the needs for sustenance and security. Above that there is a section illustrating the needs for esteem and belonging, and above that a final section illustrating the needs for growing and being.

Learning Principle: Even at advanced levels students continue to learn through the iconic mode; iconic experiences help to relieve the information overload of purely symbolic experiences.

Time Required for Use: 15-20 minutes

Preparation

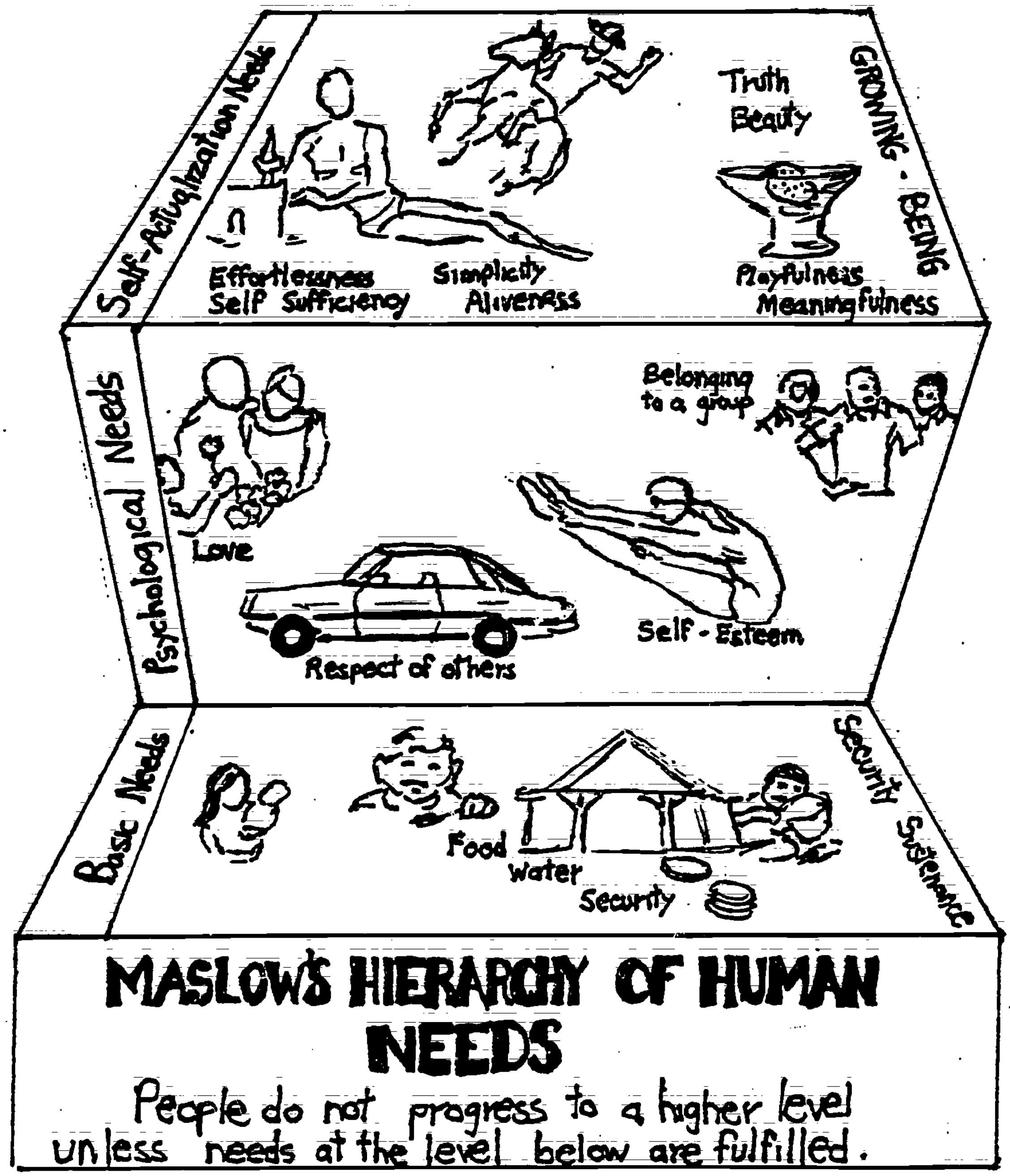
Materials Required: Heavy tagboard in two colors, felt pens in two colors, binding tape, and a variety of pictures from magazines to illustrate needs and need fulfillment at the three general levels in Maslow's Hierarchy.

Production Steps: Design the top three sections as one pyramid from a large sheet of tagboard. (In order to provide enough space in the top section, the pyramid cannot be pointed.) Cut the pyramid into three sections of equal height, and hinge them together on the back with strong sealing tape. Make the base section a bit wider than the pyramid, and use a different color of tagboard so that the title will be seen separately from the pyramid, itself. Write the three headings for the levels along the left edge of the pyramid sections: "Physical Needs", "Psychological Needs", and "Self-actualization Needs". Paste a collage of pictures appropriately on each section of the chart and add captions.

Teaching Suggestions

Mention that Maslow discovered that human beings tend not to progress to higher levels of motivation until their lower needs have been fulfilled. Ask students what the most basic needs of people are; show the lower section of the chart to illustrate their comments. Ask them what needs they think arise at the next level when the physical needs are being reasonably well satisfied; illustrate with the middle section of the chart. Continue with the top level.

(See illustration of the chart that is provided on the next page.)


Self-Actualization Needs
Truth
Beauty
GROWING - BEING
Effortlessness
Self Sufficiency
Simplicity
Aliveness
Playfulness
Meaningfulness
Psychological Needs
Belonging to a group
Love
Self - Esteem
Respect of others
Basic Needs
Security Sustenance
Food
Water
Security
MASLOW'S HIERARCHY OF HUMAN NEEDS
People do not progress to a higher level unless needs at the level below are fulfilled.

TRANSPARENCY SET TO ABSTRACT KEY CONCEPTS:
Piaget

Purpose: A device to enhance understanding of key behaviors at Piaget's four developmental levels by contrasting their attributes.

Description: A base transparency showing the names of the four stages across the top with characteristics of the sensorimotor level filled in; three overlays of characteristics of the other three levels; plus four summary overlays for the four levels.

Learning Principle: A well organized presentation with emphasis on significant contrasts enhances learning.

Time Required for Use: 12-20 minutes

Preparation

Materials Required: Transparencies, Transparent tape

Production Steps: 1. Type a one-page chart of Piaget's developmental levels.
2. Cut it apart to show characteristics of the four levels in vertical strips.
3. Make four transparencies, one of each strip in correct position.
4. Hinge transparencies together at left side.
5. Make four more vertical transparencies showing heavily lettered contrasting key characteristics for each level, and hinge them to bottom of base transparency to flip up over typed columns.

Teaching Suggestions

Project on large screen for large class. Steps:

1. Project base transparency showing four columns heading for the levels and the details of the sensorimotor column; discuss content of first column.
2. Add overlays one at a time and discuss characteristics of Preoperational, Concrete Operations, and Formal Operations Levels.
3. Ask students to identify key characteristics in each column that make that level different from the others. Flip up the summary strips from the bottom as each column is discussed.

(See examples on the next three pages.)

PIAGET: LEVELS OF DEVELOPMENT

	Sensori-motor (0-2 yrs)	Preoperational (2-7)	Concrete Operations (6-12)	Formal Operations (11-15-Ad)
Motor	Reflex activity: sucking, grasping Moves hand to mouth Manipulates objects			
Language	Spontaneous vocalization Repeats unusual utterances			
Perception Conservation	Consciously repeats a pleasureable act Does not differentiate self vs. objects Retains images of absent objects			
Cognitive	Does not know objects exist when out of sight Knows absent objects exist Uses one behavior as a step to another Infers some cause and effect Experiments with new techniques when old ones do not solve simple problems			

PIAGET: LEVELS OF DEVELOPMENT

	Sensori-motor (0-2 yrs)	Preoperational (2-7)	Concrete Operations (6-12)	Formal Operations (11-15-Ad)
Motor	Reflex activity: sucking, grasping Moves hand to mouth Manipulates objects			
Language	Spontaneous vocalization Repeats unusual utterances	Uses word as symbols Uses sentences Spontaneously uses scalars: big, small, long Rapid development	Spontaneously uses vectors: more, longer, smaller one	
Perception Conservation	Consciously repeats a pleasureable act Does not differentiate self vs. objects Retains images of absent objects		Arranges 5 objects serially by color, size Recognizes items do not change weight when changing shape	Recognizes items do not change volume when changing shape
Cognitive	Does not know objects exist when out of sight Knows absent objects exist Uses one behavior as a step to another Infers some cause and effect Experiments with new techniques when old ones do not solve simple problems	Uses mental pictures to represent objects Has some metacognition ability Understands only own point of view (egocen.) Classifies objects by a common feature Does transductive reasoning from specific to specific. Reasons in forward direction only (no reversibility) Assumes correlated events have a cause-effect relation.	Begins to understand conceptual network relations Discovers transivity: syllogistic reasoning Begins using inductive logic with concrete problems. Can reverse thinking from from addition to subtraction in concrete problems.	Classifies complex ideas using only symbols (no pictures) Can imagine things never seen Can combine ideas to hypothesize implications or incompatabilities Begins using deductive logic Thinks through possible problem solutions systematically Can handle hypotheses and hypothetical reasoning

PIAGET: LEVELS OF DEVELOPMENT

	Sensori-motor (0-2 yrs)	Preoperational (2-7)	Concrete Operations (6-12)	Formal Operation[s] (11-15-Ad[ult])
Motor	Reflex activity: sucking, grasping Moves hand to mouth Manipulates objects			
Language	[illegible] vocalization Repeats unusual utterances	[illegible] Uses sentences Spontaneously uses scalars: [illegible] Rapid development	[illegible] more, longer, smaller one	
Perception Conservation	Consciously repeats a [illegible] Does not differentiate self vs. objects Re[illegible] of absent objects		[illegible] by color, size [illegible] do not [illegible] when changing shape	[illegible] do not change volume when changing shap[e]
Cognitive	[illegible] objects exist when out of sight Knows absent objects exist Uses [illegible] behavior as [illegible] another Infers some cause and effect Experiments with new techniques when old ones do not solve simple problems	Uses mental pictures to represent objects [illegible] ability Understands only own point [of view] (egocen.) Classifies objects by a [illegible] Does transductive reasoning from specific to specific. Reasons in forward direction only (no reversibility) Assumes correlated events have a cause-effect relation.	[illegible] to understand con[illegible] relations Discovers transivity: syllogistic reasoning [illegible] inductive [illegible] concrete problems. [illegible] from addition to subtraction in concrete [illegible]	[illegible] comp[lex] ideas using o[illegible] symbols [illegible] Can imagine thi[ngs not] seen Can combine ide[as] [illegible] implications [illegible] [illegible] deductive [illegible] possible prob[lem] solutions syst[em]atically Can handle hypot[hes]es and hypot[het]ical reasoning
Some key characteristics →	Acts directly on reality as it is observed. Is ego-centric.	Internalizes and uses language symbols in communicating and thinking.	Forms complex concept networks (schemata) based on concrete thinking. Thinking includes conservation and reversibility.	Revises schemat[a] by abstract thinking. Can hypothesize beyond observed reality.

STUDENT EVALUATIONS OF INSTRUCTIONAL TECHNIQUES

During the last trimester of the investigation a fifty-minute period once a week was used to try out as many instructional techniques and devices as possible with two small groups (about 10 students each) from the introductory psychology course. Students used the form on page 23 to record assessments, based on a five-point scale from 1 (low) to 5 (high). Information about two of the points is tabulated below. Because of time limitations, not all of the techniques could be assessed, but a few that are not included in this manual were included in the trials. Some techniques were rated informally (RI) in this trimester or the one before, but formal ratings were not completed because of students' time problems.

Table 3

AVERAGES FOR STUDENT RATINGS OF TECHNIQUES

Instructional Technique/Device	Difficulty Level of the Problem		Effectiveness of the Technique	
Group:	A	B	A	B
Inductive Learning Demonstration with Flash-Cards (Incidental Learning)	3.1	2.7	3.6	3.4
Contrasting Designs to Explain a Process (Chunking)	2.5	2.0	4.0	4.1
Structured Overview of a Chapter		RI		RI
Concept Attainment Technique	3.4	2.8	4.6	2.9
Three-Step Abstraction Process to Teach a Complex Concept		RI		RI
Diagrammatic Representation of an Explanation (Regression)		RI		RI
"Cloze" Technique for Teaching Technical Terms (Nervous System)		RI		RI
Transparency with Overlays to Explain Physical Characteristics (Blind Spot)		RI		RI
Accordion Chart Illustrating Language Style		2.3		3.0
Set of Slides to Illustrate Perceptions (Depth/Distance Cues)		RI		RI
Technical Vocabulary Log for Study Triads		RI		RI
Quick Demonstration of a Psychological Function (Cognition)		RI		RI
First-Hand Concept Development Experience (Confabulation)		3.5		4.3
Mini-Experiment to Demonstrate a Concept (ESP)		RI		RI
Transparency Pyramid Illustrating a Developmental Process (Schema)	3.6	2.6	4.3	3.8
Contrasting Experiences to Clarify Processes (Inductive/Deductive)	3.1		3.6	

(continued)

Averages for Student Ratings of Techniques (Continued)

Instructional Technique/Device	Difficulty Level of the Problem		Effectiveness of the Technique	
Group:	A	B	A	B
Self-Testing Technique to Foster Comprehension (Metacognition)	3.2	2.8	4.3	3.3
Recorded Comparison (Linguistic Competence vs. Linguistic Performance)	3.4		3.4	
Folding Chart (Deep Structure, Surface Structure)	2.8		4.0	
Transparency Summarization Set (Kohlberg Moral Development)	3.1	2.8	4.3	3.9
Expanding Chart (Maslow's Hierarchy)	3.3	2.1	4.4	3.3
Transparency Set to Abstract Key Concepts (Piaget)	2.8	2.4	4.5	3.8
<u>Techniques and Devices Rated but not Included in the Manual</u>:				
Transparency with Classification Worksheet (Personality)	2.1		4.3	
Simple Explanatory Transparency (Criterion/Norm Referenced Tests)	2.9		3.9	
Chart with Template Flaps for Complex Concept Development (Paradigm)		2.4		3.2
Transparency on Historical Evolution of a Concept (Moral Development)	2.8	2.8	4.3	3.9
Folding Display Strip for a Quick Experiment (Retroactive Inhibition)		1.7		3.3
Pocket Chart for Teaching a Complex Concept (Semantic Network)	1.4	2.3	2.6	3.0
Chart Directing Comparative First-Hand Experiences (Heuristic-Algorithmic)	2.5	2.9	4.3	3.6

During the first year of the project a statistical analysis of academic factors revealed that the volunteer groups used in the investigation were not significantly different from the general population of Pitt students. It was assumed, therefore, that the second-year groups, likewise, were fairly representative of the population. Twenty percent of the students in these groups or in earlier groups indicated difficulty with each item for which a technique was prepared. This is reflected by difficulty ratings in the table ranging from 1.4 (little difficulty) to 3.6 more than average difficulty). It was interesting to note during instructional periods that students who felt they had little or no difficulty with an item usually indicated that they understood it far better after the instructional technique was used. This is apparent from the higher ratings given in the effectiveness column than in the difficulty column.

Group A gave high ratings of four points and above to more of the techniques and devices than did B. But the B-group still found them of more than medium value usually. It appeared that students particularly appreciated procedures that involved them in manipulating materials, in vigorous discussion, and in taking notes. They also appreciated the more complex transparency and chart presentations.

The final assessment of the instructional techniques will take several years and the involvement of interested instructors at Pitt and elsewhere.

Chapter 5

RECEPTIVE LANGUAGE PROBLEMS

P H Y S I C S

The numbers of reading and listening difficulties encountered by experimental groups from introductory physics classes during four trimesters from Fall of 1980 through Spring of 1982 were as follows:

	Total Problems	Serious Problems
Technical Vocabulary	148	54
General Vocabulary	43	13
Explanations of Principles and Generalizations	29	7
Metaphors of the Discipline.	13	3
Specialized Language Style Factors of the Discipline	3	0
Complex Sentence Structures.	2	0
Tabular, Graphic and Formula Presentations in Physics: Difficulties Noted.	3	0

Any item that students mentioned as a difficulty was considered to be a problem, but an effort was made not to avoid including items merely because they were new. An item was considered to be a serious problem if it was classed as a difficulty by twenty percent or more of any group and if it could not be easily understood or answered by referring to the text or to another readily available source. Since most of the students at the University of Pittsburgh are from the upper forty percent of their high school classes, more problems might be listed as serious in colleges that admit a larger proportion of high school graduates. Surely one could expect more problems with sentence complexity among less competent students. Likewise, a small proportion of difficulties would be serious in a more selective school.

As might be anticipated, the largest number of difficulties was with technical vocabulary. Although the number of serious difficulties in explanations of principles and generalizations was not great, failure to understand even a few such key items could result in very poor achievement for the students. It appears that metaphors and special language style factors may be used less frequently in introductory courses than is likely in more advanced courses.

The problems encountered in the experimental groups from the four classes in physics are itemized below. The classification of an item as technical vocabulary, general vocabulary, metaphor, etc., had to be based on somewhat subjective judgements, so other educators may prefer to classify some items differently. Those problems that seemed to be serious are starred.

TECHNICAL VOCABULARY IN PHYSICS: THE DIFFICULTIES NOTED

adiabatic
*angular acceleration
*angular distance
angular momentum
angular orientation
*angular velocity
*anthropomorphic
*apparent weight
Avogadro's number
Boltzmann's constant
Boltzmann's distribution
bomb calorimeter
Brownian motion
buoyancy
buoyant force
calorie
calorimetry
*cantilever
Carnot engine
*center of gravity
*center of mass
*centrifugal force
*centrifugation
*centripetal acceleration
*centripetal force
*circular motion
closed system
coefficient of friction
compression
conduction
conductor
constant acceleration
continuity incompressibility
convection
cosmology
co-tangent
deceleration
delta
*density
design speed
displacement
dissipative forces
dynamic equilibrium
*dynamics
eddy
*elastic limit
elastic modulus
electric field
electroscope
emissivity
*equinox
equivalents
escape velocity
extensor
*flexor
flow-rate
*free-body diagrams
free-fall
*frequency of revolutions
*frequency of rotation
friction
fulcrum
gauge pressure
gravitational constant
gravitational field intensity
*gravitational mass
*heat engine
*heat of fusion
*heat reservoir
*heat of vaporization
hydrostatic
*impulse
inertial mass
*insertion
*instantaneous speed
insulator
intensity
internal energy
isobaric
isolated system

joint
*joule
*kinematics
kinetic friction
laminar flow
latent heat
*lever arm
macrostate
manometer
mean speed
mechanical energy
microstate
*mole
molecular mass
moment arm
*moment of inertia
*net force
*normal force
open system
*parallax
partial pressure
perturbations
polarization
potential energy
pressure head
*projectile motion
*radian
radiation
*radius of gyration
*relative velocity
*retrograde motion
reversible process
root mean square velocity
*rotational kinetic energy
satellite
specific gravity
specific heat capacity
state function
state (of matter)
static equilibrium
static friction
*statics
steady flow
streamline flow
subtended
*tangential
*tangential acceleration
tangential force
thermal efficiency
*thermal energy
thermal stress
thermodynamics
thermography
*torque
torr
translational kinetic energy
translational motion
turbulent flow
uniform circular motion
*vector
*vector addition
*velocity
vertical motion
viscosity
*weight
*weightlessness
*work
Young's modulus

GENERAL VOCABULARY USED IN PHYSICS: THE DIFFICULTIES NOTED

analogous
arches
area
causality
collision
*components
conservation
deformation
distance
domes
efficiency
*elasticity
energy
entropy
environment
*equilibrium
feedback
fluids
*force
*gravity
ground
incline
inertia
intensity
machine
*magnitude
*mass
*mechanics
momentum
*motion
plasma
plasticity
power
pressure
prime (and double-prime)
pumps
restoring
safety factor
*speed
strain
*stress
*temperature
*tension

EXPLANATIONS OF KEY PRINCIPLES, GENERALIZATIONS, OR COMPLEX CONCEPTS IN PHYSICS: THE DIFFICULTIES NOTED

1. Archimedes Principle:

   "The bouyant force on a body immersed in a fluid is equal to the weight of the fluid displaced by the body."

   Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. pp. 156-9.

2. Boyles' Law:

   "For a given mass of gas at constant temperature, the product of pressure and volume is constant, i.e. the volume of the gas varies inversely as the pressure." (This law holds only for ideal or perfect gases.)

   Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 41.

3. Charles' Law: (Charles-Gay-Lussac Law)

   For a perfect gas: "the volume of any gas at constant pressure rises with temperature by a constant fraction of the volume at 0°C., i.e. the coefficient of expansion is the same for all gases."

   Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 55.

4. Coulomb's Law:

   "The force between two charges is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square."

   Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 345.

5. Dalton's Law of Partial Pressure:

   "Each gas in a mixture exerts a partial pressure proportional to its molecular concentration."

   Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 197.

6. The force of friction is equal to the force applied when an object moves at constant velocity.

7. The frequency of rotation equals the number of complete revolutions made per second.

8. Geocentric Theory: (Ptolemaic Theory)

"According to 2^{nd} century Greek astronomers, the earth was assumed to be the center of the solar system, consisting of the Earth, Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn--arranged in order of increasing distances from the earth--and all these 'planets' were assumed to be going around the earth in orbits with complex motions."

Arya, Atam P. Introductory College Physics. New York: Macmillan Publishing Co., Inc., 1979. p. 215.

9. Gravitational and Electromagnetic forces; which represent adding a weak force and a strong force together, result in a unity of forces.

10. Gravity is a constant force at a given location regardless of the weight of an object.

*11. Heliocentric Theory (Copernican Theory):

"Nicolaus Copernicus, a Polish monk, proposed this theory in which the sun is supposed to be at rest in the center of the solar system, while all the other planets revolve around the sun."

Arya, Atam. Introductory College Physics. New York: Macmillan Publishing Co., Inc., 1979. p. 216.

12. Hookes' Law:

The distortion of a system is directly proportional to the applied distorting force and is in the direction of the force. (In relation to elastic-potential energy).

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. pp. 101-2.

13. Ideal Gas Law:

"For a given quantity of gas it is found experimentally that to a good approximation, the volume of a gas is inversely proportional to the pressure applied to it; i.e.: the volume of a gas is inversely proportional to the pressure applied to it when the temperature is kept constant."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 191.

14. Irreversible process (i.e. real process in relation to the Second Law of Thermodynamics):

"A process at the conclusion of which it is not possible to return the system involved to its original thermodynamic state--by the second law of thermodynamics all natural physical processes are irreversible."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. pp. 261-2.

15. Isothermal Process: (The First Law of Thermodynamics)

"An idealized process that is carried out at constant temperature."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 251.

*16. Kepler's Laws of Planetary Motion:

(I) "Every planet moves in an ellipse of which one's focus is the sun."

(II) "A planet moves more quickly along the parts of its orbit that are closer to the sun, and more slowly as it moves away from the sun."

(III) "The ratio of the squares of the periods of any two planets revolving about the sun is equal to the ratio of the cubes of their average distances from the sun."

Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 187.

17. Kinetic Theory:

"Matter is made up of atoms and these atoms are in continuous random motion."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 181.

18. Maxwell's Distribution (Maxwell-Boltzmann Distribution Law):

"For a perfect gas: a law giving the average number of molecules having speeds within well-defined limits. If you could count the number of molecules moving at a certain speed within a gas, you would find very few moving at extremely fast or extremely slow speeds, with most of them moving at an 'average' speed. If you would graph the number of molecules moving at each speed, the result would look like a curve."

Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 213.

**19. Newton's Law of Gravitation:

States that "every particle of matter in the universe attracts every other particle with a force acting along the lines joining the particles."

Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 231.

**20. Newton's Laws of Motion:

(I) Newton's First Law of Motion:
"Every body continues in a state of rest or uniform motion unless acted upon by a force."

**21. (II) Newton's Second Law of Motion:
"The rate of change of momentum of a body in a given direction is proportional to the resultant force applied to it in that direction."

**22. (III) Newton's Third Law of Motion:
"To every action there is an equal and opposite reaction."

Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 231.

**23. Pascal's Principle:

"The earth's atmosphere exerts a pressure on all fluids and the pressure is transmitted through the fluid and acts in all directions."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. pp. 151-2.

24. Planetary motion is related to the equal and opposite gravitational pull between planets and their distance from each other.

25. Pythagorean Theorem:

A theorem in Geometry which states: "the square of the length of the hypotenuse of a right triangle equals the sum of the squares of the lengths of the other two sides."

American Heritage Dictionary of the English Language (New College Edition). Boston: Houghton-Mifflin Co., 1979. p. 1065.

26. Second Law of Thermodynamics:

"Heat flows naturally from a hot object to a cold object; heat will not spontaneously flow from a cold object to a hot object."

Thewlis, J. Concise Dictionary of Physics. New York: Pergamon Press, 1979. p. 333.

27. Toricelli's Theorem (re: fluid flow):

"Liquid will flow at the same speed that a freely falling object would attain falling the same height."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 167.

28. Torque gives rise to angular acceleration; therefore, no torque, no rotation.

29. Work-Energy Theorem:

"The network done on an object is equal to it's change in kinetic energy. If work is done on an object, its kinetic energy increases. If an object has kinetic energy, it can do work on something else; and if it does, its own kinetic energy increases."

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980. p. 128.

METAPHORS USED IN PHYSICS: THE DIFFICULTIES NOTED

(Metaphors might be considered merely technical terms, but they are more than that because they use other words that usually are quite common to explain by comparison or analogy. Obviously a couple of these metaphors are in general use rather than being limited to physics.

1. The depositing charge is that which is dependent on the relative charge (±) of depositor and depositee; may refer to addition or removal of electrons to/from material.

2. The earth exerts a force to keep the water in which is also known as gravity.

3. Using a rotating frame of reference: Newtonian laws do not hold to be true; regarding relative speed and velocity.

4. Being hit with a ton of feathers would be the same as being hit with a ton of bricks because the weight of the object is related to the density.

5. Inertia might be referred to as laziness of a body/system.

6. Kinetic energy is "stored work" or energy that remains at rest until there is a need.

*7. In order to visualize the electric field, a series of lines of force are drawn to indicate direction of the force due to the given field on a positive test charge.

**8. An object exerts a force or feeling which is in the opposite direction of the motion which is parallel to the surface and perpendicular to the force applied by the object.

*9. Centrifugal force may be thought of as a non-accelerated coordinate frame in that the particles do not accelerate but the system does. A person outside of the system sees (proper) motion differently.

10. Entrophy is the disorder of a system; it is often referred to as "time's arrow" as it tells in which direction time is going.

11. The right hand rule of thumb to use for angular momentum is to remember that it remains constant.

12. "Still waters run deep" may be related to Bernouilli's Principle in that where the velocity of a fluid is low, the pressure is high.

13. The tensile stress of which a body will fracture or will continue to deform with decreasing load is known as the ultimate strength.

SPECIALIZED LANGUAGE STYLE FACTORS IN PHYSICS: THE DIFFICULTIES NOTED

(Specialized language style factors involve the use of words in sequences or combinations that are unique to a particular discipline but not to every-day expression in other areas. The words would be easily understood separately, but the discipline-specific arrangement may make the expression difficult for the novice to understand.)

1. The equation of state is related to the physical condition of a system.

2. Life depends on high quality energy (e.g. sunlight) that maintains ability to do work.

3. An orbiting object with constant speed is accelerating (Change is occurring as direction continually changes).

COMPLEX SENTENCE STRUCTURES IN PHYSICS: THE DIFFICULTIES NOTED

1. High flow speed = low pressure (vice versa)
   ∴ pressure drops at constriction in flow.

2. A depositing charge depending on relative charge (+) of depositor and depositee may refer to addition or removal of electrons to/from material (depositee).

TABULAR, GRAPHIC, AND FORMULA PRESENTATIONS IN PHYSICS: DIFFICULTIES NOTED

1. F(n) = normal force

2. $\bar{a} = \frac{f}{\text{mass}}$

3. $\bar{w} = \frac{\theta}{t}$

Chapter References

The textbooks and references from which some explanations in this chapter were drawn are:

Arya, Atam P. Introductory college physics. New York: Macmillan Publishing Co., 1979.

Giancoli, Douglas C. Physics. New Jersey: Prentice-Hall, Inc., 1980.

Hooper, Henry O. and Gwynne, Peter. Physics and the physical perspective. San Francisco: Harper & Row, Publishers, Inc., 1980.

Joyce, Bruce and Weil, Marsha. Models of teaching. New Jersey: Prentice-Hall, Inc., 1980.

Orear, Jay. Physics. New York: Macmillan Publishing Co., Inc., 1979.

Thewlis, J. Concise dictionary of physics. New York: Pergamon Press, 1979.

Chapter 6

INSTRUCTIONAL TECHNIQUES FOR PHYSICS

Lists were provided in Chapter 5 of 241 difficulties in receptive communications that were experienced by students in introductory physics classes; 77 of these were considered to be fairly serious. During the second year of the project the team outlined approximately 35 instructional techniques and devices to use in preventing or overcoming some of these problems. The ideas were gleaned from participating faculty members, from references, and from earlier teaching experiences of the team members. Each technique was tried out informally with a group of students, and if found promising, was developed further and tested on one or more groups as time permitted. Summaries of student evaluation for techniques used during the final trimester are given on the last page of this Chapter.

Space limitations make it possible to describe only 24 of the techniques here. These procedures were selected to show a variety of first-hand experiences, simple demonstrations, transparency sets, charts, and guided study methods that can be used with classes of different sizes. The list, with pages where they can be located, follows:

ACCORDION CHARTS PRESENTING VARIED HEURISTIC STRATEGIES

Purpose: A device to demonstrate a set of processes for problem solving that leads the student to select one which is most comprehensible and usable for that individual.

Description: A series of accordion charts is presented, each demonstrating a different problem-solving technique, as well as an example of a completed problem. Each frame of the accordion chart represents a different step in a problem-solving sequence. If one of the problem-solving processes does not include a step present in one of the other processes, the appropriate frame of the accordion chart is left blank to represent that missing step.

Learning Principle: Different students within a class utilize various learning styles.

Time Required for Use: 20 minutes

Preparation

Materials Required: Heavy paper or poster pages for accordion chart
Marking pens
Masking tape for hinging pages together

Production Steps: Write each step of a problem-solving strategy on a different page, and then hinge the pages together in sequence.

Teaching Suggestions

1. Keep comparable steps parallel from chart to chart (one step on one chart may equal two or more steps on another).
2. Compare and contrast the different problem solving strategies.
3. Go through the solution of the actual problem, indicating which aspects of each problem-solving strategy are operating at each stage of the actual solution process.
4. This lesson is most easily used in small groups, although it also may be used by an instructor as a part of a large class lecture.
5. This method may be used to present other systematic learning strategies such as textbook study systems, notetaking methods, varied algorithmic processes for answering a problem, etc.

(Refer to examples on the following five pages)

1. Define
   - Identify the actual problem

Woods, D.R., Wright, J.D., Hoffman, T.W., Swartman, R.K., and Doig, I.D., "Teaching problem-solving skills." Engineering Education, 66,238-243(1975).

2. Think About It
   - What are the attributes?
   - Identify area of knowledge
   - Collect information
   - Diagram solution

3. Plan
   - Think up alternative plans
   - Translate the problem

4. Carry Out Plan
   - Solve the problems

5. Look Back
   - Check reasonableness and math
   - Check criteria and constraints
   - Study related problems
   - Identify application in physics, everyday behavior, and on a deserted island.
   - Identify order - of - magnitude numbers
   - Study problem-solving skills learned.
   - Communicate results.

e the Unknown

e the System

knowns, concepts and choose symbols.

e the constraints

e the criteria

.G., Moreland, J.L.C., Ross, D.C.,
A., Problem-solving: a freshman
Engineering Education, 67, 172-176(1976)

Substep 1: Define the Unknown

- identify the unknown concept or variable to be solved for.
- Know the correct meanings of both the common and technical words used in the problem statement.
- carefully compare your statement of the unknown with the original Problem statement

Substep 2: Define the System

- carefully draw a diagram (from different viewpoints, if useful)
- identify major influences (eg., forces, flows of energy)
- identify inputs and outputs to the system
- make the diagram as simple as possible, but do not oversimplify.

List knowns, concepts, and choose symbols.

f the known information, select a each concept, define the units and en numerical values.

e ambiguous symbols (don't use V and velocity, for example). Use of mbols may sometimes help.

of units, the dimensions, and units in the problem should be identified.

Substep 4: Define the Constraints

- The words "only," "must," "neglect," or "assume" help to identify constraints.
- A common difficulty is to use all of one's knowledge or experience to complicate a problem--attempt a simple version of a problem first.

Substep 5: Define the Criteria

Examples of criteria include:

- is the solution error - free?
- does the solution make sense? (does it agree with your experience in solving similar problems?)
- does the solution demonstrate educational merit? (that you know the subject matter)

Know order of magnitude values.

The Think About It Step

- Possibly redraw the diagram to represent a variety of views and levels of complexity.

ead written problems carefully!
common error is to leave out
word or two when reading, which
an completely change the sense
f a problem.

Adapted from: Giancoli, D.C., Physics.
Englewood Cliffs, N.J.: Prentice-Hall
(1980)p.55.

2. Draw a picture or diagram of the situation (this is crucial, yet often overlooked). Use arrows to represent vectors such as velocity or force. Use a separate diagram for different types of vectors; i.e., one for force and one for velocity, if both types of vector are involved. Make clear what forces act on what body (or you can make an error in determining the net force acting on a particular body.

3. Determine what the unknowns are -- that is, what you are trying to solve for.

t you need in order to find the unknowns.
lp to see if there are one or more
hips (or equations) that relate the
to the knowns; but be sure that the rela-
is applicable in the given case. Beware
as that can't be applied generally--those
y only in a specific case(it may be danger-
umb through a book looking for any equation
s like it might work). Know the limita-
each formula or relationship -- when it
and when it is not.
o helpful to determine what information
the problem is relevant and what is
t.

5. Solve the problem, which may include algebraic manipulation of equations and/or numerical calculations. Be sure to keep track of units, for this can serve as a check.

6. Ask yourself: "Is the answer reasonable?" Use your common sense here. Also;
-"Order of magnitude estimating" (making a rough estimate by rounding all numbers to a power of 10, and calculating an answer composed of one digit times its power of 10)--helps to eliminate decimal point errors.
-"Dimensional analysis" may also be helpful. Such analysis yields two simple rules: (1) we can add or subtract quantities only if they have the same dimensions (we can't add centimeters and pounds), and (2) quantities on each side of an = sign must have the same dimensions.

ethod IV

1. Read the problem
   - make sure you understand the terminology
   - review terms that you do not know

2. Make a drawing of the problem
   - identify the quantity that you are seeking
   - identify the given values on which the solution depends
   - identify unknown values that must be calculated from other information in order to find the solution
   - make sure that all quantities are expressed

3. Establish which general principle relates the given parameters to the quantity you are seeking (and which associated formulae). Generate further information, if needed, prior to formula selection.

Adapted from: Maxwell, M., Improving Student Learning Skills
San Francisco: Jossey Bass (1979.

4. Calculate the solution
   - Calculating the values of any variables to be obtained from the given information, then
   - plug all of the given and calculated values into the main question.

5. Criticize your solution to see if it makes sense.
   - Compare it with available examples
     Many times an error in calculation will result in an obviously wrong solution.
   - Check the units in which your solution is expressed, and make sure that they are appropriate.

Examining your solutions will develop your intuition about correctness of solutions, and this will be of immense help on tests.

1. The Problem as Given

A home gardener uses an 800-lb. garden tractor to pull a 200-lb. cultivating machine to prepare his garden for planting. The tractor and cultivator accelerate at 8 ft./S^2. If the drag of the ground (the force of friction) is 300 lb., what is the total force that the ground is exerting to accelerate both the tractor and the cultivator? This is the reaction force to the tractor's tires pushing against the ground.

Adapted from: Hooper, H.O., and Gwynne, P., Physics and the Physical Perspective. San Francisco: Harper & Row (1980), pp. 69-70.

2.

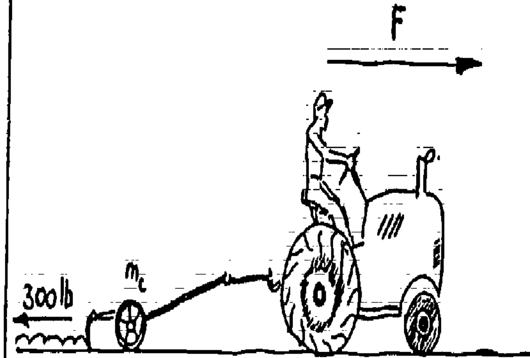
Problem: What is the total force that the ground is exerting on the tractor to accelerate it and the cultivator.

System : The tractor, the cultivator, and the ground.

Principle applying: Newton's Second Law of Motion--the acceleration of a body is directly proportional to the net force acting on it and inversely proportional to its mass.

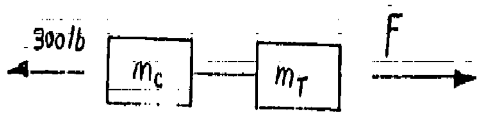
Formula : $F_{net} = m_{total}a$

3. Realistic Illustration



$m_c = \frac{W_c}{g} = \frac{200 lb}{32 ft/s^2}$ $m_T = \frac{W_T}{g} = \frac{800 lb}{32 ft/s^2}$

4. Free Body Diagram



$m_{tot} = m_c + m_T = \frac{1000 lb}{32 ft/s^2}$

5. Solution

$F_{net} = m_{total}a$

$(F - 300\ lb) = \left(\frac{1000\ lb}{32\ ft/S^2}\right) 8\ ft/S^2$

$(F - 300\ lb) = 250\ lb$

$F = 300\ lb + 250\ lb$

$F = 550\ lb$

6. Criticize the Solution

- Have any errors been made?
- Does the solution generally make sense?
- Does the solution fit the problem as it is written? As it is pictured?

PEER GROUP INTERACTION

TO INDUCE A SET OF CONCEPTS

<u>Purpose</u>: A technique to have students generate varied explanations for a set of concepts, subsequently delimiting the precise physics definition.

<u>Description</u>: Break the class into groups of four students each. Have the groups define each of the four concepts. (Concepts may be chosen from group Physics books or previously presented class material.) Each group member then takes one of the concepts and presents its definition to representatives from the other groups who share their definitions of the same concept. Finally, after comparing notes and reaching a conclusive definition, these concept-specifi groups select a leader to present their final difintion/s to the class.

<u>Learning Principle</u>: Students working in small groups can generate more ideas than when working alone (and may learn from each other).

<u>Time Required for Use</u>: 35 minutes

Preparation

<u>Materials Required</u>: Students
Pencils and paper
Chalk and chalkboard

<u>Production Steps</u>: Write the four concepts to be considered on the board, divide the class into groups of four, and proceed. (Use information that has been previously presented in class.)

Teaching Suggestions

1. The instructor may wish to remind the groups to include physics-oriented definitions at a given stage of the process.
2. The end results should be used to qualitatively contrast lay, physics, and other technical uses of a term.
3. Such small group processes usually work best with classes of small-to-moderate size or with laboratory/recitation sections.
4. Example of the procedure:

   <u>Step I</u>. Break the class into groups of four students and have each group explain one of the selected terms or phrases.

Examples of Group Responses to "Power"

Group 1

- control of others
- supply of energy
- rate at which energy is emitted
- forcefulness

Group 2

- ability to get extra base hits
- rate at which work is done
- amount of magnification (i.e., of a microscope or telescope)

Group 3

- how many times you multiply a number by itself
- rate at which energy is transferred
- legal authority

Group 4

- political influence
- physical might
- ability of a stat. test to reject null hypothesis
- the ability to act effectively

This procedure is then repeated with each of the remaining terms. The students should record each response for each term for later use.

Step II. Reorganize the class into concept specific groups. A concept specific group should contain at least one member from each of the initial groups. Each group is then assigned one of the previously defined concepts and the task of making a list of all of the definitions suggested by the students during Step I. From this list, the group members draft a condensed list of definitions.

Example of List Developed by a Concept Specific Group

- political/legal authority
- physical prowess
- exponent
- statistical ability to reject a null hypothesis
- rate at which work is done, or energy is produced or transformed

Step III. Each group then selects a leader who shares the group's definitions with the class.

Step IV. The instructor expounds upon the correct Physics definition - further explaining and giving examples, and contrasting the Physics concept with the other proposed definitions, as appropriate.

(Refer to example on following page.)

Possible Example of Peer Group Arrangement with Twenty Students (numbered 1 - 20)

Step I INITIAL GROUPS

1	5	9	13	17
2	6	10	14	18
3	7	11	15	19
4	8	12	16	20

Step II CONCEPT-SPECIFIC CONCEPTS

1	5	9	13	17
2	6	10	14	18
3	7	11	15	19
4	8	12	16	20

Step III CONCEPT GROUP LEADERS

5 14 11 20

STRUCTURED SUMMARY BLOCK DESIGN

Purpose: A device to lead students to generate an appropriate structure to organize the principles, theories, complex concepts and technical terms found in introductory textbooks.

Description: A list of major concepts and technical terms from a content unit is presented on the chalkboard for student categorization. The modular block design is passed out to the students on handout sheets. They first categorize one term as a main main topic and then those terms that fall hierarchically beneath it as subtopics. Each appropriate subtopic may then be placed in the box at the top of a subsequent handout sheet. Then, the remaining terms and major concepts, or additional ones draw from the class text, are categorized beneath the subtopic in the subordinate boxes.

Learning Principle: Concepts are developed through categorizing and classifying.

Time Required for Use: 20 minutes (additional time may be required as homework)

Preparation

Materials Required: Handout sheets for students. Instructor may use a transparency identical to the handouts or draw the same schema on the board.

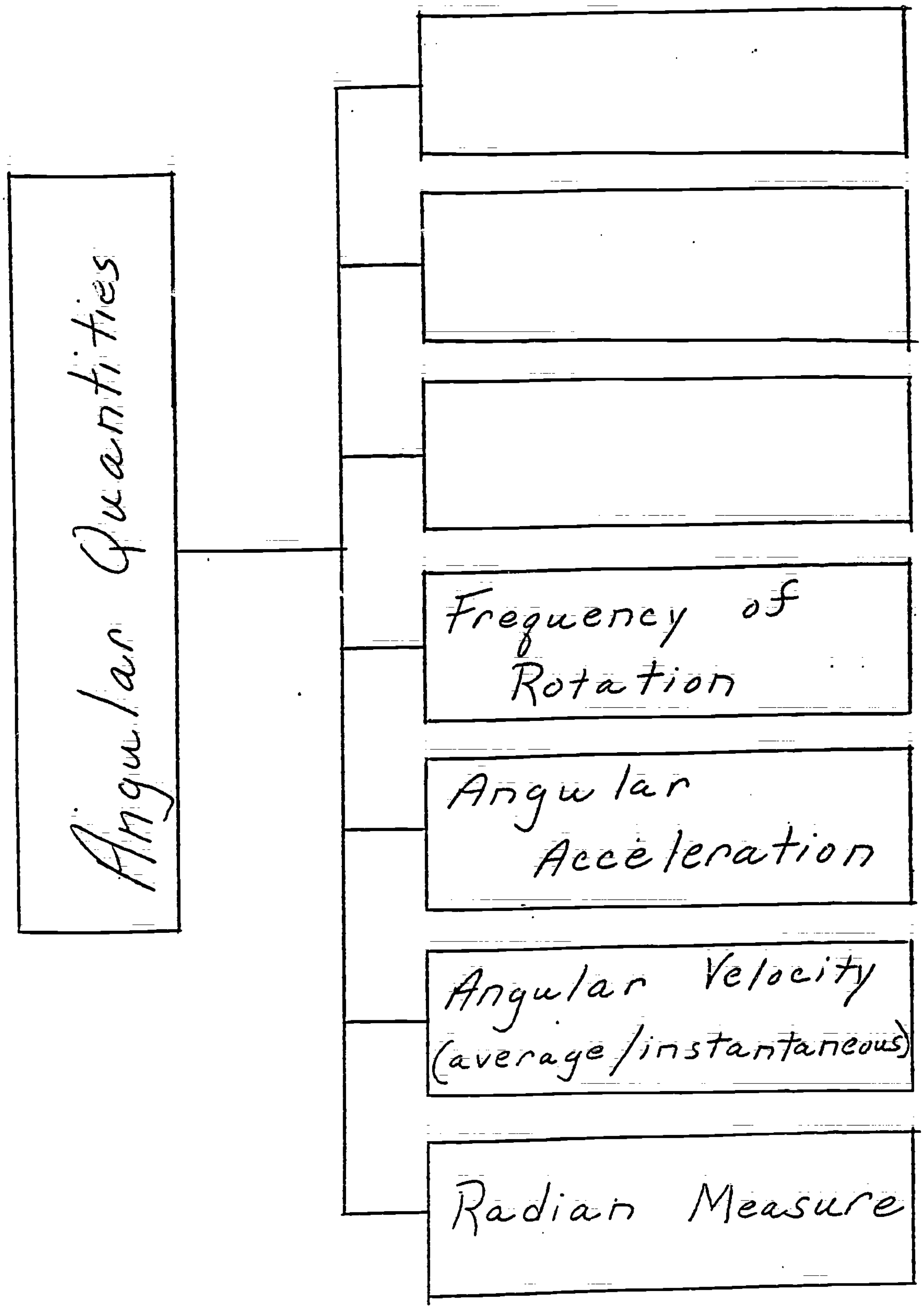
Production Steps: Draw or reproduce the block design as illustrated on the following page.

Teaching Suggestions

1. Although student generation of such structures is essential, the presentation of the instructor's categorization scheme may also be important to the students as a reference point.
2. The students may wish to include a brief definition or explanation in each box along with the term. As an option the term can be listed in a question followed by a brief answer.
3. This technique may be used before the instruction of a unit as a student developed structural overview, during the period as a method of notetaking and summarization, or after the unit is completed as a post instructional graphic organizer.
4. instructor developed set of structured summary blocks which include questions can be placed on reserve status in the college library or learning center for students to review and prepare for examinations.

(Refer to the example on the following page.)

STRUCTURED SUMMARY BLOCK DESIGN



ACTIVE DEMONSTRATION OF CONCEPTS

Purpose: A technique to develop the students concepts by having them directly experience concepts for words such as acceleration, impulse, momentum and displacement.

Description: After students have studied certain concepts, list them on a chalkboard or handout. Give certain students instructions to perform, and have the class explain what was demonstrated:

1) Time a student accelerating from a standstill and running a straight distance. Determine speed vs. velocity, acceleration vs. deceleration, and distance vs. displacement.
2) Repeat the above, with the student running in a semicircle. Inertia may also be described as the "pull" on the runner as the turn is rounded.
3) Have a runner accelerate from a standstill to demonstrate impulse (contrast with acceleration).
4) Have a small and large person proceed at the same velocity for the same distance and try to stop suddenly to demonstrate their different momenta.
5) Have two equally-sized people proceed at two different speeds, again demonstrating momentum differences.

Learning Principles: First-hand experience facilitates the learning of concepts covered in class.

Time Required for Use: 10-15 minutes

Preparation

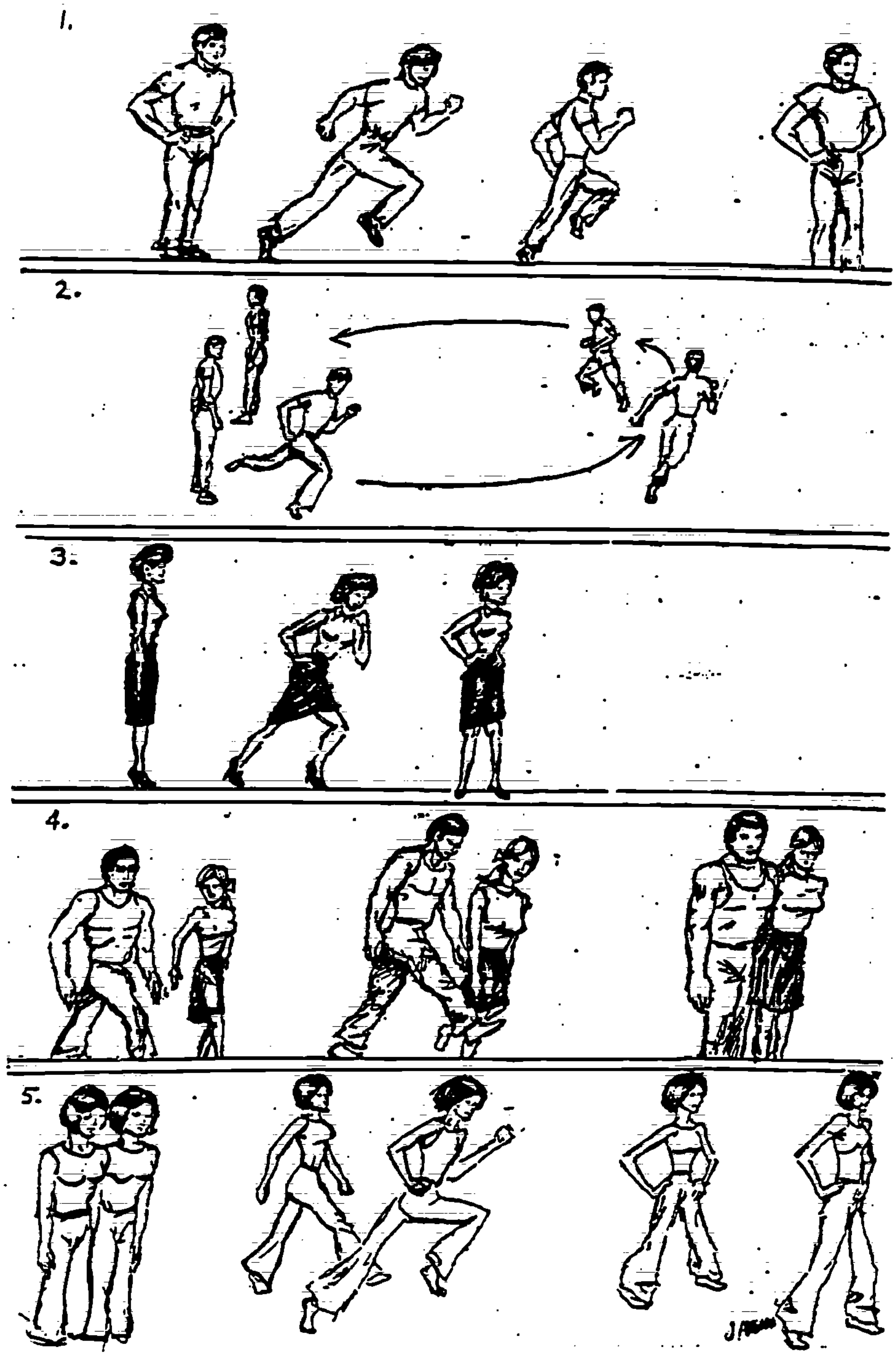
Materials Required: Stop watch or watch with second hand. Large room or outside open area with pre-measured distances or reference points. Chalkboard or handout sheet.

Production Sheets: Measure and set up demonstration area. List terms for selection on board or handout.

Teaching Suggestions

This lesson is best used when one is teaching a small group of students or when a small group demonstrates while others observe. It may also be adapted for use as an out of class assignment.

(See illustration on the following page.)


1.
2.
3.
4.
5.

WORKING MODEL TO DEMONSTRATE

THE ELEMENTS OF MOTION

Purpose: To physically demonstrate displacement, velocity, and acceleration.

Description: A simple electric slot car race track is used. The distance around the track for each car is measured with a flexible measuring tape, and a stopwatch is used to time the velocity of the cars. An oval shaped track, or one with a curve built into one straightway, are the best devices.

Learning Principle: Students learn and remember from first-hand experience.

Time Required for Use: 15 minutes (set-up time additional)

Preparation

Materials Required: Electric slot car raceway with two cars
Tape measure
Stop watch

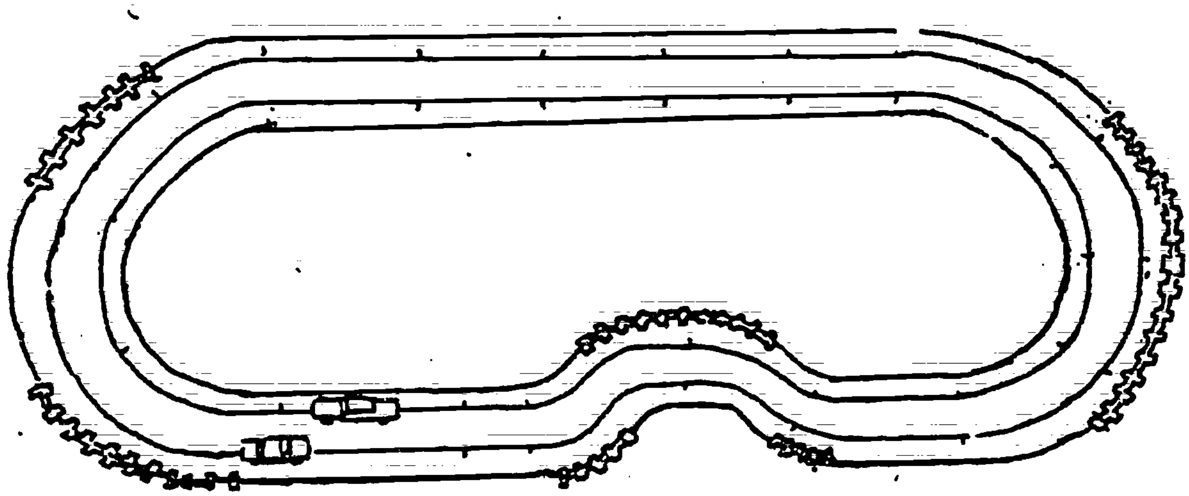
Production Steps: Assemble raceway

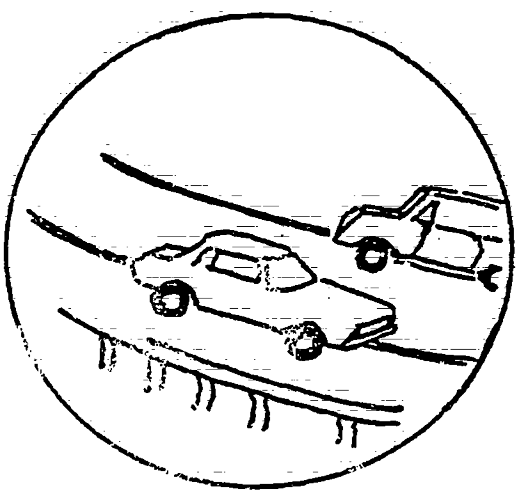
Teaching Suggestions

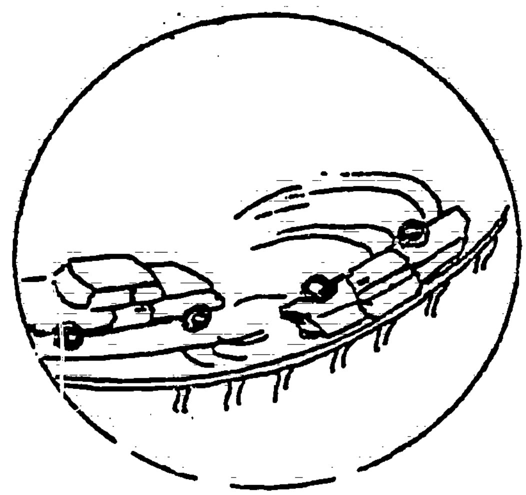
1. Demonstrate that one full lap is zero displacement for both cars, despite the fact that each car covers a different distance.
2. Measure the approximate speed, velocity, acceleration and impulse of a car as it moves at constant speed and at various, discrete speeds. This is done by using the stopwatch and measuring tape.
3. Find the speed at which inertia causes the car on the inside track of a curve to derail, while the car on the outside track negotiates the curve.
4. Momentum may also be demonstrated by using a barrier (e.g., a rubber block) and determining the amount of velocity that must be built up to have the car move the barrier.
5. An electric train may be substituted for most of the above demonstrations.
6. This device is best used in a small group situation.

(Refer to model on the following page.)

WORKING MODEL TO DEMONSTRATE THE ELEMENTS OF MOTION







DEVICE TO DEMONSTRATE

NEGATIVE ACCELERATION

Purpose: A device to demonstrate the principle of the negative acceleration created by friction.

Description: A negative acceleration or deceleration is created because of friction. A block of wood is placed on the board of a rigid swing that comes to rest at the level of the table top (See drawing). The student will draw the swing back a known distance, release it, and allow it to collide with the table. The block is shot from the swing and it comes to rest after skidding across the table. The deceleration and the force of the friction are computed.

Learning Principle: Visualization of a concept facil[illegible] a learning experience.

Time Required for Use: 10 minutes

Preparation

Materials Required: 2 Small wooden blocks (a 2-inch block; a 4-inch block)
Several lengths of coat-hanger wire (or bailing wire)
Beaker stand
Spring balance

Production Steps:
1. Attach hanger wire to 4-inch block (Making a swing).
2. Attach topmost part of wire to beaker stand which is stationed at the edge of the lecture table.

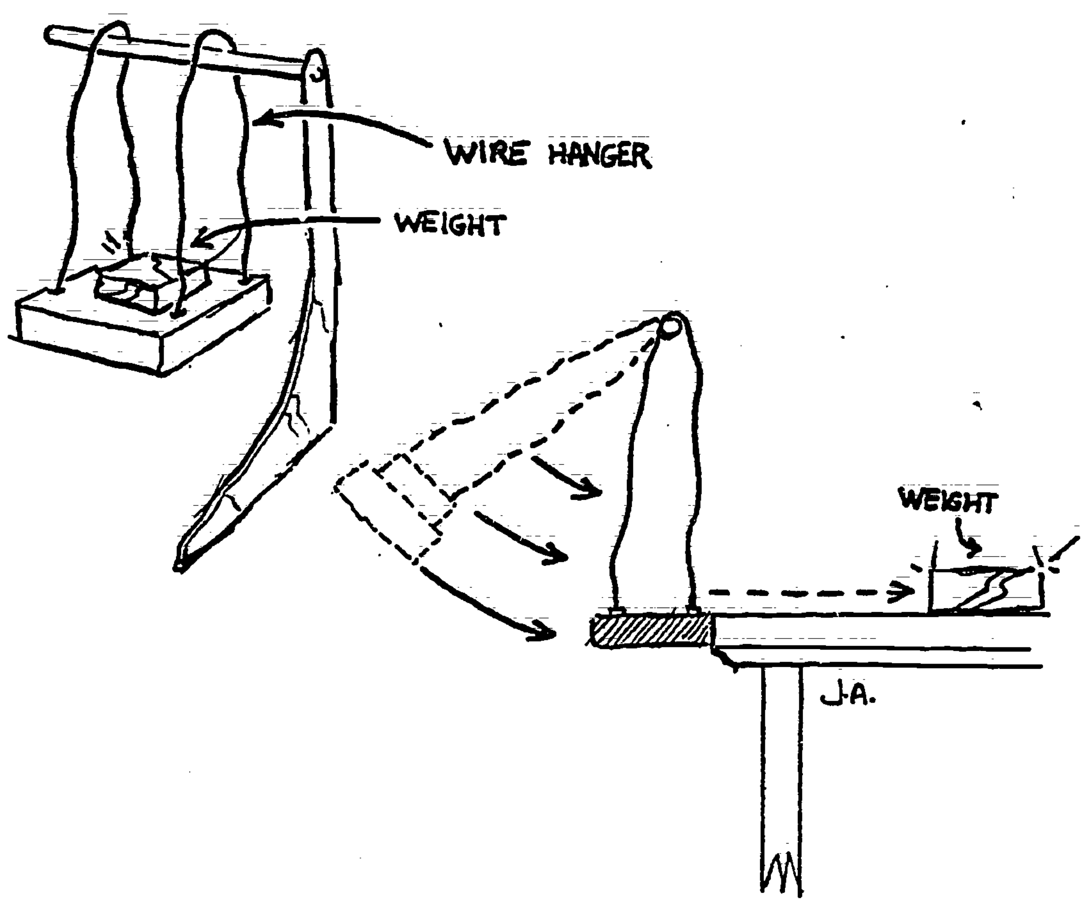
Teaching Suggestions
(Use for lecture)

1. A block of wood is drawn over the lecture table top by a spring balance and the force of friction is observed.
2. Then the block is placed on the board of a rigid swing that comes to rest at the level of the table top. (See drawing on next page.)
3. The swing is drawn aside a known distance, released, and allowed to collide with table.
4. The block is thus shot from the swing with a known initial velocity and comes to rest after skidding across table.

5. Compute the negative acceleration and relate it to the force of the friction.
6. If desired, the block of wood may be weighed and the force of friction, the mass of the wood, and the negative acceleration could be discussed in terms of the equation F=MA.
7. As an option, several additional blocks of varying weights may be utilized.

(See the following illustration)

DEVICE TO DEMONSTRATE NEGATIVE ACCELERATION (DECELERATION)



CRITICAL ATTRIBUTE LIST

TO DEFINE TECHNICAL TERMINOLOGY

Purpose: A technique to contrast the attributes that accurately define a term (e.g., mass) with previously learned attributes that are not directly related to the technical definition.

Description: A list of critical attributes that accurately define a term is drawn up. Attributes which students have inaccurately associated with the term are listed in like manner. The lists are then reviewed, compared, and contrasted.

Learning Principle: Concepts are sharpened through contrastive thinking; learning can proceed from the general to the specific.

Time Required for Use: 3 minutes

Preparation

Materials Required: Handout sheets and overhead transparency containing the critical attribute information in list form.

Production Steps: Duplicate the lists of critical attributes vs. inaccurate attributes in the appropriate format.

Teaching Suggestions

When reviewing the attributes on the lists in sequence, the instructor may use an overhead projector with the transparencies. This strategy allows the instructor to mask the lists so as to reveal one attribute at a time. If appropriate, the lists should be drawn up in parallel fashion.

(Refer to the example on the next page.)

EXAMPLE OF A CRITICAL ATTRIBUTE LIST

MASS

is

CRITICAL ATTRIBUTES

1. A basic measure in physics.
2. The quantity of matter in a body.
3. The measure of inertia (sluggishness) shown by a body in response to a net force
   a) a measure of how diffiuclt it is to start a body in motion.
   b) a measure of how difficult it is to stop or slow down a moving body.
   c) a measure of how difficult it is to change the direction of a body's motion in a straight line.
4. Measured in kilograms, grams, or pounds.
5. Related to density, volume, and weight.
6. A determinant of the gravitational force between two bodies.

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

MASS

is not

INACCURATE ATTRIBUTES

1. Weight
2. Density
3. Volume
4. Necessarily a large quantity
5. Necessarily without specific shape
6. A nonspecific amount of measure

PULLEY TRUCK DEVICE TO DEMONSTRATE NEWTON'S SECOND LAW

Purpose: A device to develop the understanding that the time rate of change of momentum of a body is equal to the net force acting on the body.

Description: A small truck attached to a weight and a pulley is placed upon a horizontal track. A metronome is started. As it clicks, the truck is released. The table is marked with chalk to indicate where the truck is at each click of the metronome.

Learning Principle: Understanding is attained through a meaningful first-hand experience.

Time Required for Use: 5-6 minutes

Preparation

Material Required: Small toy flat bed truck (match box type)
Laboratory table
Small weights
Several lengths of string
2 pulleys
Metronome
Liquid accelerometer (optional)

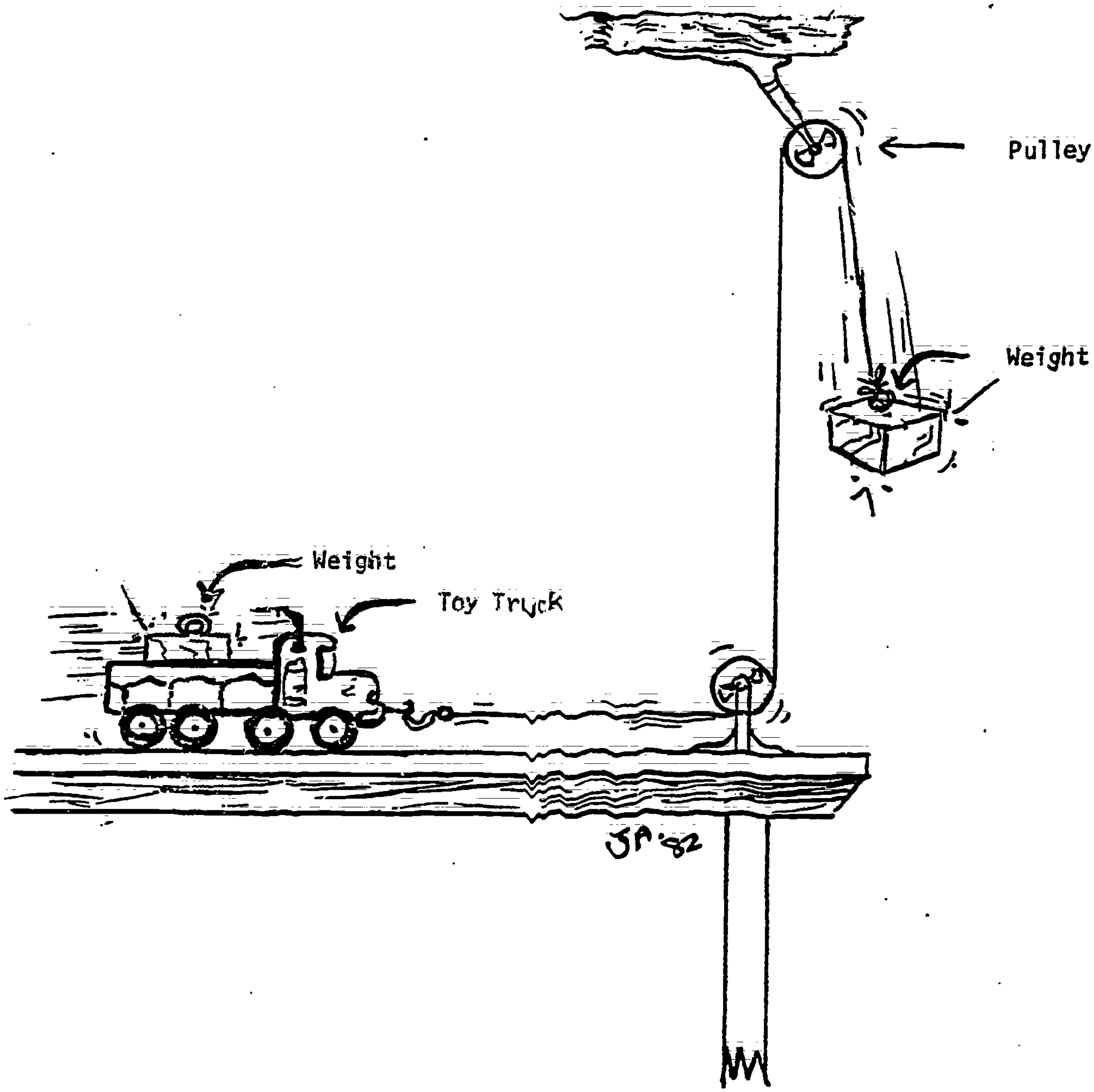
Production Steps:
1. Attach 1 pulley to edge of lecture table.
2. Attach second pulley to area above lecture table.
3. Attach string to toy truck and connect to pulleys.

Teaching Suggestions

1. The accelerating weight and mass of the truck may be varied.
2. The acting force may be made of longer duration if the cord passes over a pulley high above table.
3. Several students may be lined up along the table, each with a piece of chalk. Each student is given the responsibility of making the position of the truck at a different click of the metronome.
4. The acceleration may be observed as the change in distance between chalk marks.
5. The acceleration may be made immediately visible by means of a liquid accelerometer carried on the truck. (see drawing).
6. A flatcar from an electric train set can be placed on a length of track as a substitute for the matchbox style toy truck.

(See illustration on the following page.)

PULLEY TRUCK DEVICE TO DEMONSTRATE NEWTON'S SECOND LAW



SKETCHES OF ALTERNATE DEFINITIONS TO CLARIFY TECHNICAL MEANINGS

Purpose: A device to facilitate student recall of various meanings of a term (e.g., normal), and to select which meaning is physics-appropriate.

Description: Have students quickly generate several definitions for a term, and present prepared drawings or diagrams as the depicted explanation is brought up. The instructor should supply major alternatives that the students might not include. At the conclusion of this activity, the instructor should discuss the ways in which the alternative definitions apply (or fail to apply) to physics.

Learning Principle: The iconic mode of presentation can clarify points not understood through the symbolic mode alone.

Time Required for Use: 5 minutes per technical term

Preparation

Materials Required: Chalk and chalkboard
Transparencies with marking pens, or charts

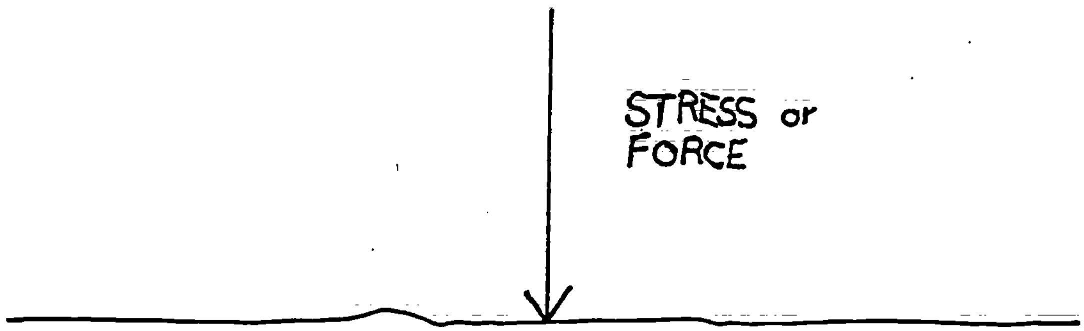
Production Steps: Reproduce or draw sketches/diagrams on medium of choice.

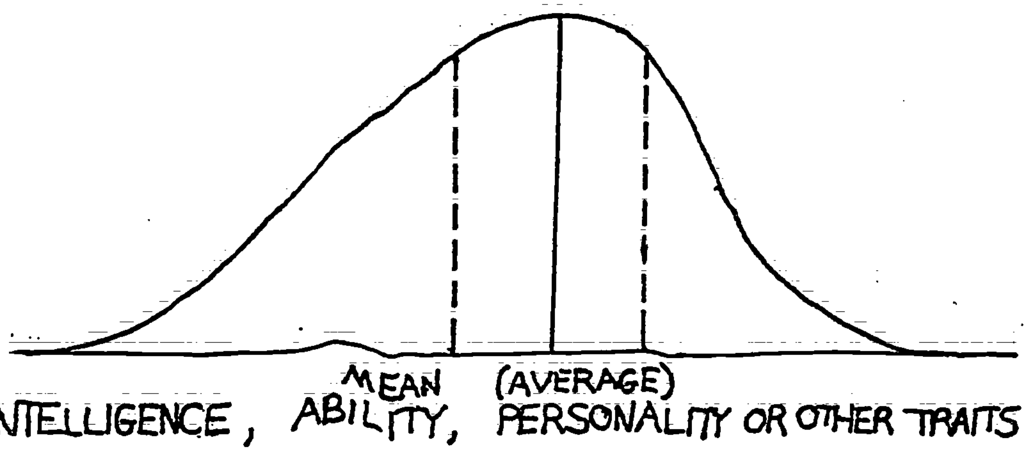
Teaching Suggestions

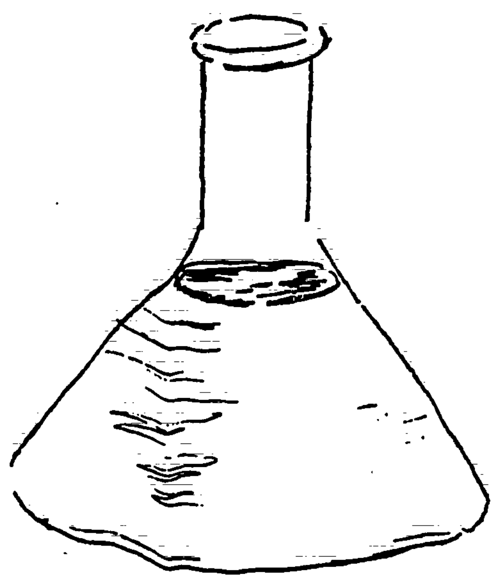
This device would be most efficacious with terms that are easily confused with general vocabulary or other technical uses of the term. The technique is equally suited for large or small group teaching situations.

Example of alternate definitions for "normal": 1. Conforming to a typical pattern; regular. 2. Not changed by experimentation (especially biology). 3. Occurring naturally (especially biology). 4. Being perpendicular, at right angles (e.g., stress or force) (geometry and physics). 5. Average in intelligence, ability, emotional traits, or personality, (especially psychology). 6. A solution having a concentration of one gram equivalent of solute per liter (especially chemistry).

(See illustration on the following page.)


STRESS or
FORCE


MEAN (AVERAGE)
INTELLIGENCE, ABILITY, PERSONALITY OR OTHER TRAITS



1 gram / liter

PIE-CHART EXPLANATION

OF A QUANTITATIVE TERM

Purpose: This device is to provide students with a precise visual image of radian angles.

Description: A pie-chart is constructed, with the "pieces" of the pie corresponding to the 6.28 radians in one circle. The cumulative number of radians and the cumulative number of degrees per radian are given in each pie section. Reference points of 45°, 90°, and 180°, are also given. A mask designed to sequentially reveal the sections of the chart is removed as the chart is explained.

Learning Principle: Concrete visualization helps some students accurately by increasing their ability to understand and use concepts.

Time Required for Use: 3 minutes

Preparation

Materials Required: Two sheets of construction paper and a brass fastener, or one sheet of construction paper and one transparency.

Production Steps: Draw or reproduce the base chart as illustrated on the following page.

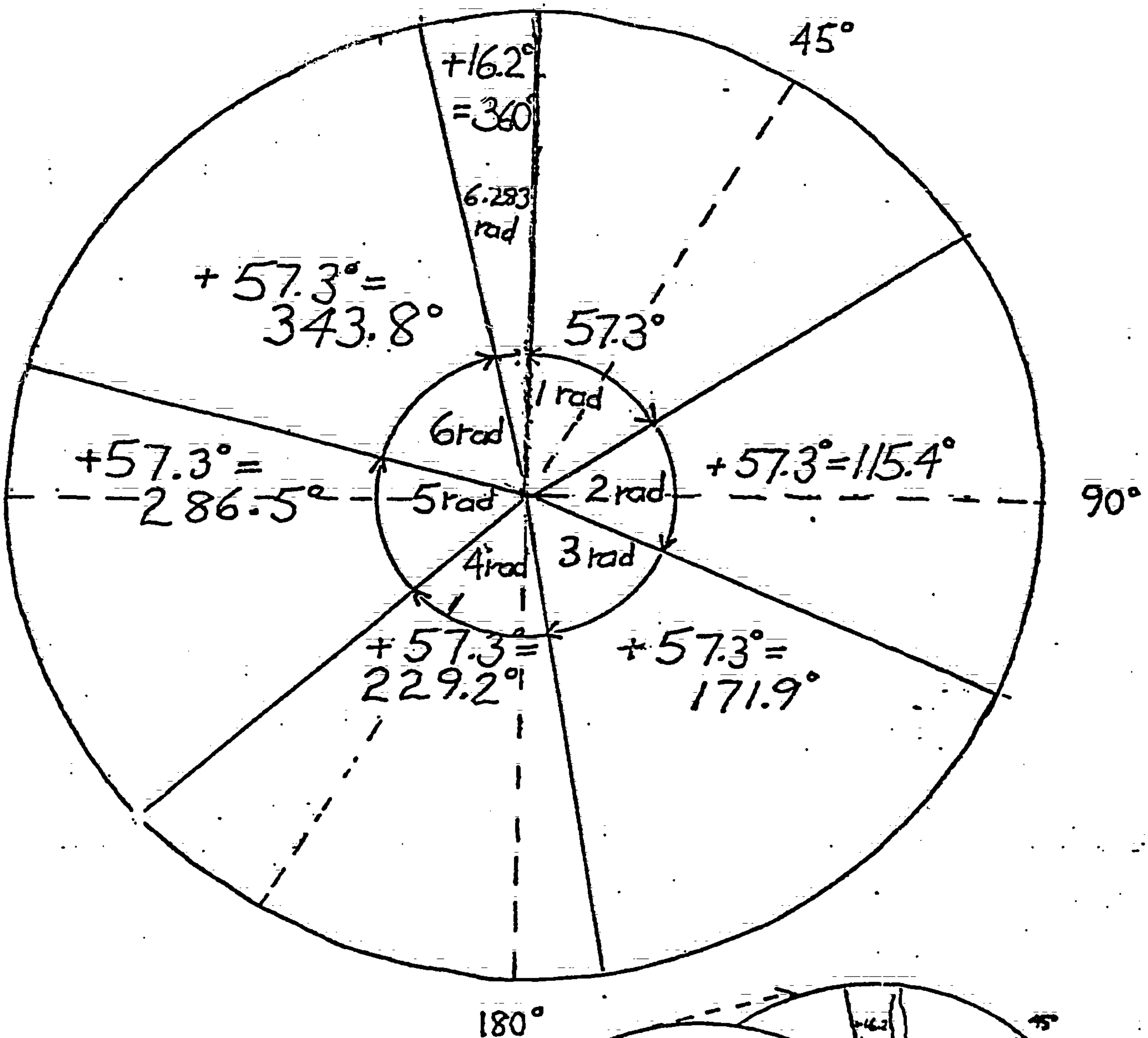
1. For transparencies: place pieces of masking corresponding to each pie section over each section.
2. For opaque charts: cut along the baseline radius of the base chart and then cut out a circular mask. That is the same circumference as the base chart. Attach the mask to the chart by putting the fastener through the center of both. The mask is able to slide under the chart at the baseline.

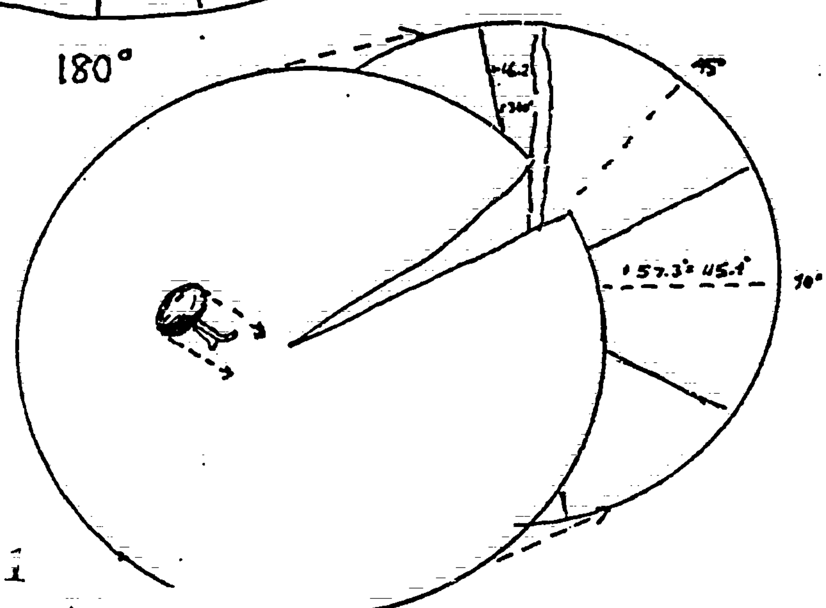
Teaching Suggestions

1. The opaque chart is more appropriate for use in small groups, while the transparency may be best suited for overhead projection in a larger classroom setting.
2. After defining radians as "one rad = 57.3°", the instructor may clarify how such measurement relates to traditional degree measurement by referring to the reference points at 45°, 90°, and 180°. The "2π rad per circular revolution" definition may also be related to the exact number of radians per circle.
3. Instructors may wish to stress $\pi/2 = 90°$, $\pi = 180°$, $3\pi/2 = 270°$, and $2\pi = 360°$.

(Refer to the illustration on the following page.)

RADIAN MEASURE FOR ANGLES





MECHANISM TO DEMONSTRATE NEWTON'S LAW OF UNIVERSAL GRAVITATION

Purpose: A device to demonstrate how the force of gravity between two objects varies as a function of mass and distance.

Description: A model is assembled consisting of dowel rods of three arbitrary lengths (0.5, 1, 1.5) that interchangeably pivot atop a stand. Spheres (or objects of other shapes) may be placed on the ends of the dowels, with one pair of objects of each of three arbitrary masses (0.5, 1, 1.5). As the objects and dowels are interchanged, the relative mass and distance measurements may be computed into the gravitational force equation. A smaller mass (.001, relatively) may be placed on one sphere, and the force of gravity computed between it and both spheres.

Learning Principles: Learning is produced by vicarious experience.

Time Required for Use: 15-20 minutes

Preparation

Materials Required:
- 1 stand (such as a camera tripod or a music stand)
- 3 lengths of dowel rod, one 1½ times and one ½ the size of the reference dowel
- 3 pairs of styrofoam spheres (or other shapes) one pair 1½times and one pair ½ the size of the reference shape
- 1 small piece of putty

Production Steps: Drill holes through the middle of each dowel (the size of the tip of the stand) and in the midpoint of the diameter of the styrofoam shapes (the size of the end of the dowels). The dowel rods fit atop the stand, with the top of the stand fitting through the hole in the middle of each dowel. The shapes are placed at either end of the dowels, and the putty is placed on one shape.

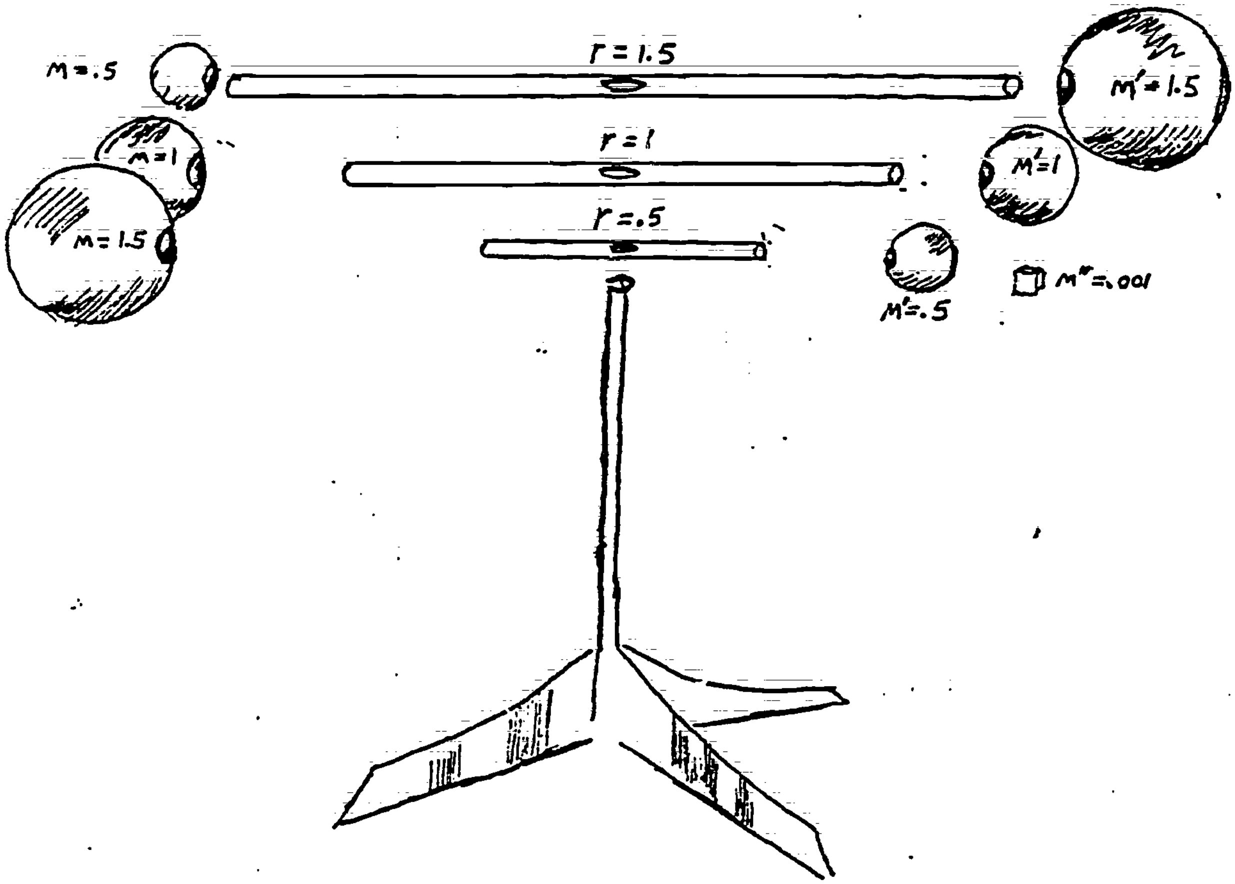
Teaching Suggestions

1. Begin the lesson by horizontally fitting the dowel length = 1 on the tripod and by attaching the objects of mass = 1 on both ends. Next write the appropriate formula on the chalkboard. The students then calculate the force of gravitation between the two objects.

2. As the lesson procedes, systematically vary the "mass" of the objects and also the distances between them. Before a gravitational force is calculated ask the students how or why it will differ from the last force that was calculated.
3. After the students calculated the force of gravity (either individually or with a peer), the correct responses should be written on the chalkboard.
4. As a final problem, a small piece of putty can be placed on the surface of one of the objects. The students are then to calculate the forces between the putty and the objects.

(Refer to model on the following page.)

MODEL TO DEMONSTRATE NEWTON'S LAW OF UNIVERSAL GRAVITATION



Examples using shapes of m = 1 and m' = .5:

r = 1 $\quad F = G \dfrac{1 \; .5}{(1)^2} = .5\ G$

r = .5 $\quad F = G \dfrac{1 \; .5}{(.5)^2} = 2\ G$

r = 1.5 $\quad F = G \dfrac{1 \; .5}{(1.5)^2} = .22\ G$

MANIPULABLE DEPICTION OF EQUIVALENT FORMS

Purpose: A device to enable students to understand and demonstrate the equal areas "swept out" by a planet in Kepler's second law of planetary motion.

Description: A transparency or chart similar to the diagram on the following page is shown to the students. The two areas swept out by the radius of the planet's orbit in equal times are each shaded in two different colors. The pieces of one area are cut so that they may be reassembled on top of the other area to approximately demonstrate the equality of the two areas.

Learning Principle: Understanding is enhanced by the diagrammatic simulation of the event described in a law or principle.

Time Required for Use: 5 minutes (10 minutes if students manipulate the pieces)

Preparation

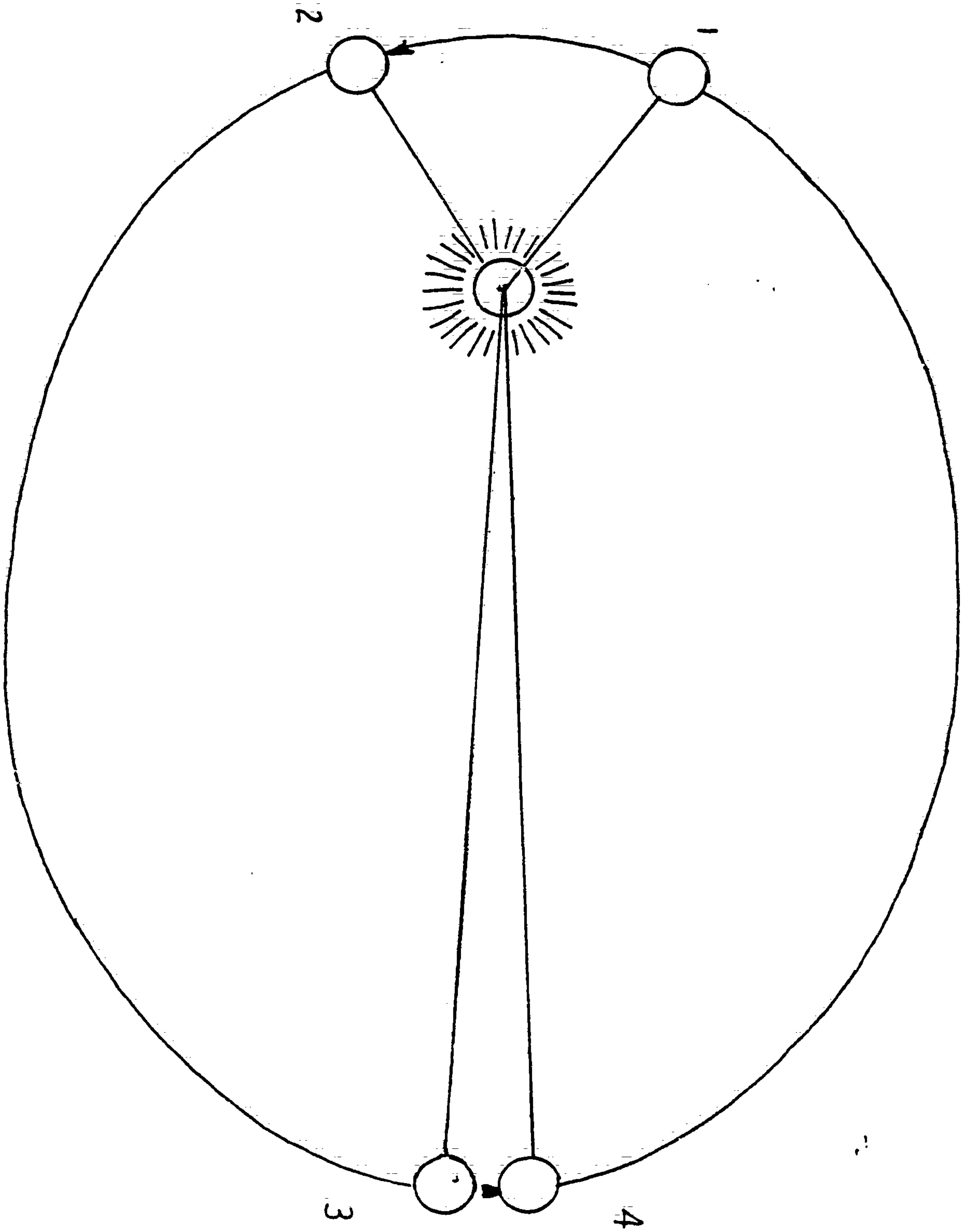
Material Required: Base transparency (or chart) and disassembled pieces of one section of the orbit's area.

Production Steps: Reproduce Diagram I and Diagram II, shown on the following pages, as either transparencies or charts. Next, cut colored pieces of transparency material or cardboard to correspond with the numbered sections found on the right side of Diagram II.

Teaching Suggestions

1. Show the class Diagram I and initially explain the principal of Kepler's second law of planetary motion.
2. Diagram II is then placed on the overhead projector (or table top), and the pieces of the orbital area on the right side of the diagram are assembled in the appropriate places. The pieces will fit exactly into this area if placed on the corresponding number).
3. Next, reassemble the pieces to fit as closely as possible into the appropriate places on the left side of the diagram.
4. A transparency is best suited for demonstration purposes in a large-group lecture. In a small group situation a chart may be manipulated by the students.

(Refer to illustration on the following two pages.)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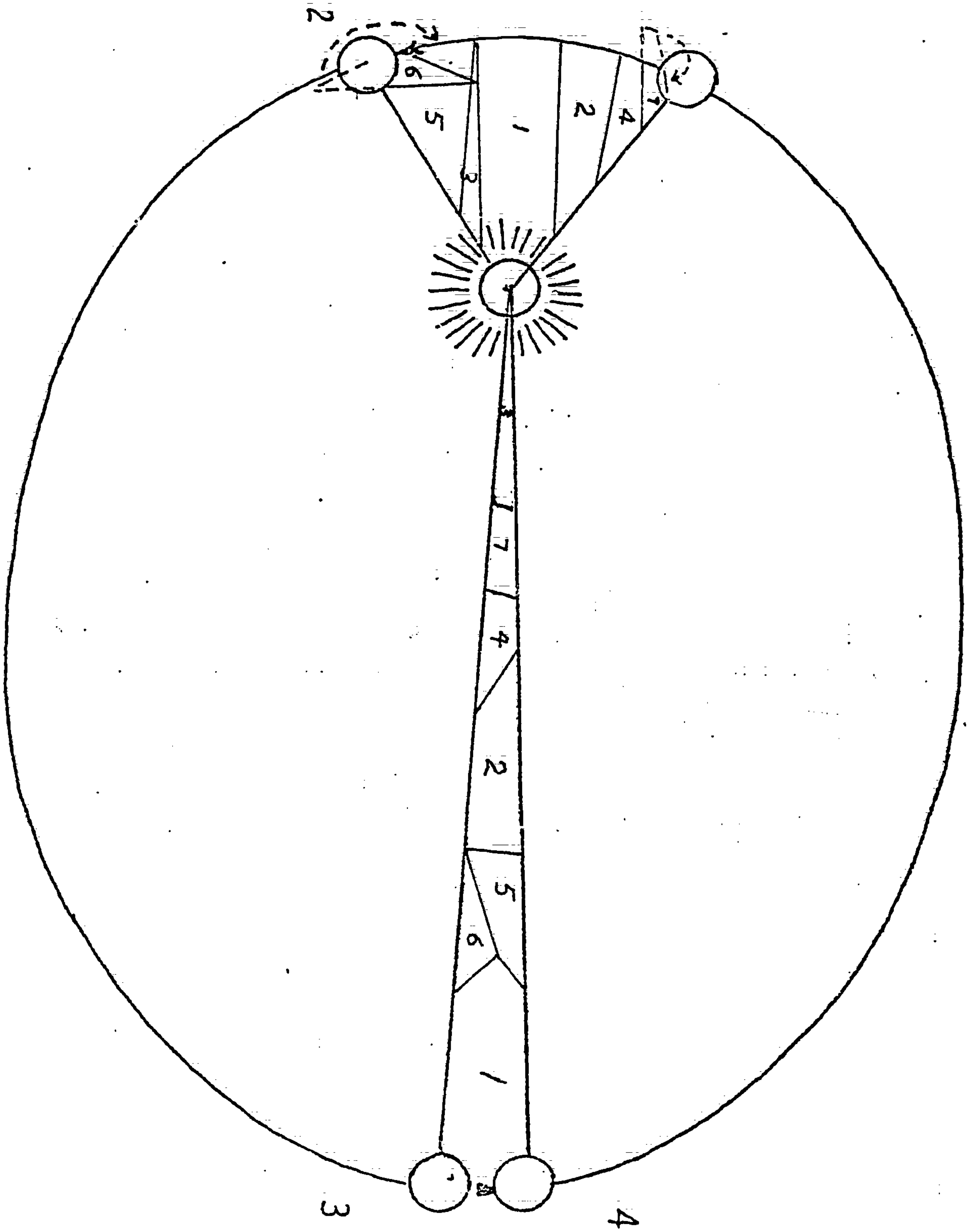
1
3
4



ETYMOLOGICAL CHARTING

OF TECHNICAL TERMINOLOGY

<u>Purpose</u>: This device to help students to grasp the essence of the meaning of a technical term by tracing its historical development (<u>e.g.</u>, moment).

<u>Description</u>: The historical development of the use of a term is charted on a timeline, and graphically portrayed using pictures or diagrams. The earliest root form of the term is given and defined, with subsequent evolutions of the term given in sequence. The development of the term's technical use might be of particular interest. Current synonyms or alternate usages may also be presented, if appropriate.

<u>Learning Principle</u>: Additional information enhances the meaning of a concept; overlearning through varied experiences contributes to long-term memory.

<u>Time Required for Use</u>: 5-7 minutes

Preparation

<u>Materials Required</u>: Transparencies for overhead projection or handout sheets in conjunction with chalk and chalkboard.

<u>Production Steps</u>: Reproduce timeline (etymology) and illustrations on medium of choice.

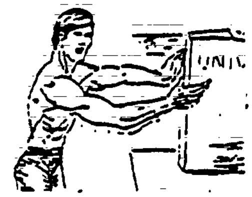
Teaching Suggestions

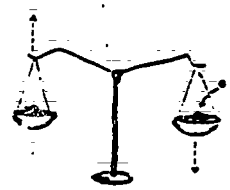
1. This lesson is appropriate for small or large group presentation.
2. The lesson may be used to introduce a term.
3. The timeline handout may be adapted to a worksheet that the students can complete for homework.
4. The lesson may be readily associated with parallel developments in the history of physics as a science.
5. Source books: (a) The <u>Oxford English Dictionary</u> provides the most complete information regarding the development of technical usages; (b) the <u>American Heritage Dictionary</u> provides basic Indo-European root words; (c) the <u>Webster's Third New International Dictionary</u> provides the best overall etymology.

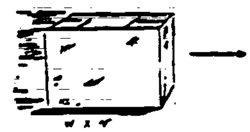
(Refer to the example on the next page.)

ETYMOLOGY

Term	Origin	Meaning
Mew-or meu-	Indo-European (about 3500 yrs. ago)	To push away
Movēre	Latin	To move
Momentum	Latin, then Old French	A movement; A particle suffi- cient to turn the scales
Moment	Middle English (1300-1475)	Equals momentum, as above
	W. Jones (1706)	Velocity x weight
	Chambers (1727-52)	Cycles, moment, momentum = impetus

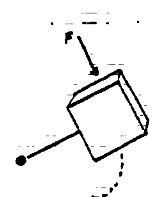




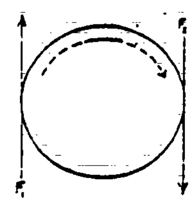


Other ways "moment" has been or is being used:

- Moment of a force : a measure of the turning effect of a force about a point (i.e., torque)--force times the leverage it has when applied to a body

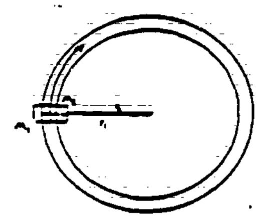


- Moment of a couple: a measure of the effect of a pair of forces of equal magnitude acting in parallel but opposite directions, capable of causing rotational but not translational motion



- Moment of momentum: equals angular momentum (L); moment of inertia X angular velocity

- Moment of inertia: the mass of each particle in a body times that particle's squared radius from the axis of rotation ($I = \Sigma mr^2$)



- Synonym: Importance (possibly - the importance of inertia in resisting angular acceleration)

POCKET CHART TO PORTRAY ANALOGOUS TERMS

Purpose: This device demonstrates the similarity between analogous terms (e.g., rotational motion vs. translational motion).

Description: A pocket chart is constructed in analogy-like format, with eight to ten pockets in each of two vertical columns. The analogous terms, definitions, and formulae are written on cards. As they are reviewed, the cards are placed into the chart pockets. The cards representing the first half of the analogy are placed into the pockets in the first column as they are reviewed. The cards representing the latter half of the analogy are placed in the second column of pockets opposite their counterparts.

Learning Principle: Analogical thinking utilizes what is known about one item or set of items to develop understanding of another item or set of items.

Time Required for Use: Dependent upon number of terms

Preparation

Materials Required: Matte board base
Index cards (4" x 6")
Marking pens
Glue (possibly a glue stick)

Production Steps: To construct the pockets, glue the index cards on three sides, placing them in a horizontal position in two columns. Write the terms on index cards that are placed vertically, so that these will fit into the pockets.

Teaching Suggestions

1. If half of the analogy has been learned, simply redescribe that half prior to the introduction of the new, analogous term. Otherwise, fully introduce both parts of the analogy and indicate the extent to which the terms are analogous.
2. Although the example on the opposite page shows a quasi-synonymous relationship, any type of relationship may be utilized.
3. This pocket chart is best used with relatively small groups due to the limitation on the size of the cards.
4. The cards can be shuffled and placed in a pile for students to use as an independent review exercise for preparing for an examination.
5. A formal definition, study questions, or reference sources may be written on the back of each card.

ANALAGOUS COMPARISON OF ROTATIONAL MOTION AND TRANSLATIONAL MOTION

	TRANSLATIONAL MOTION	is to	ROTATIONAL MOTION
as	IN A STRAIGHT LINE	is to	CIRCULAR
as	DISPLACEMENT = S	is to	ANGULAR DISPLACEMENT $= \theta$
as	VELOCITY $(v) = \frac{S}{TIME}$	is to	ANGULAR VELOCITY $(\omega) = \frac{\theta}{TIME}$
as	ACCELERATION $(a) = \frac{\text{CHANGE IN } v}{TIME}$ $\Delta v = v - v_0$	is to	ANGULAR ACCELERATION $(\alpha) = \frac{\text{CHANGE IN } \omega}{TIME}$ $\Delta \omega = \omega - \omega_0$
as	MASS IS A MEASURE OF A BODY'S INERTIA	is to	MOMENT OF INERTIA (I) = MASS (OF A BODY OR SYSTEM) $\times$ RADIUS^2
as	FORCE (F) = MASS $\times$ ACCELERATION	is to	TORQUE (τ) = FORCE APPLIED PERPENDICULAR TO THE LEVER ARM $(l \perp F)$ or $(l F \perp)$
as	MOMENTUM (p) = MASS $\times$ VELOCITY	is to	ANGULAR MOMENTUM (L) = MOMENT OF INERTIA $\times$ ANGULAR ACCELERATION

MANIPULATIVE MODEL TO CONTRAST TERMS

Purpose: A device to demonstrate how variations of specific environmental conditions result in distinctly different states of equilibrium.

Description: 1. A triangular base with a concave apex is cut out of a block of wood. A small ball is placed on the base to demonstrate unstable equilibrium.

2. The block is cut on one side so that this base fits back in with a V-shaped "valley" cut out above it; this shows stable equilibrium when the ball is placed in the valley.

3. The block is now flipped over, the base is fit in flush with the top of the block. Next, a convex piece of wood placed back in the concave tip of the base to make the block's surface level. This last condition demonstrates neutral equilibrium when the ball is placed on this level surface.

Learning Principle: Concrete visualization helps some students to accommodate new concepts.

Time Required for Use: 5-10 minutes

Preparation

Materials Required: Steel or rubber ball
One block of wood (approximately 10"x10"x2")
Masking tape (optional)
Jigsaw to cut out pieces from block.

Production Steps: Cut the base out from the wooden block, and cut the concave apex from its tip. If possible, hinge the convex piece removed from the base back onto the block with masking tape (as illustrated). Cut another section out of the block of the same size as the base, but with a V-shaped section cut out above it.

Teaching Suggestions

1. Emphasize that the ball is in equilibrium, since it is not moving, in each of its environments. However, the state of equilibrium varies.
2. Ask the students what happens to the ball's center of gravity (is it raised, lowered, or kept at the same height) as a small force is applied in each state of equilibrium.
3. Ask the students where the ball will be moved to when a small force is applied within each state of equilibrium.
4. Ask the students how much potential energy the ball has relative to its immediate surroundings in each state of equilibrium.

(See illustration on the following page.)

RATING SCALE TO DIFFERENTIATE BETWEEN TECHNICAL TERMS

Purpose: Device to assist students in differentiating between two similar terms (e.g., plasticity vs. elasticity) according to specific pertinent qualities.

Description: The two terms are selected for contrast according to a set of pertinent qualities that they have in common. The qualities that describe the two terms are listed below with each quality having a scale of one through seven. The students rate each quality along the scale on its degree of agreement with the terms at the opposite ends.

Learning Principle: Analytical thinking promotes understanding.

Time Required for Use: 5-8 minutes

Preparation

Materials Required: Handout sheets
Transparency for overhead
Projection or chalk and chalkboard

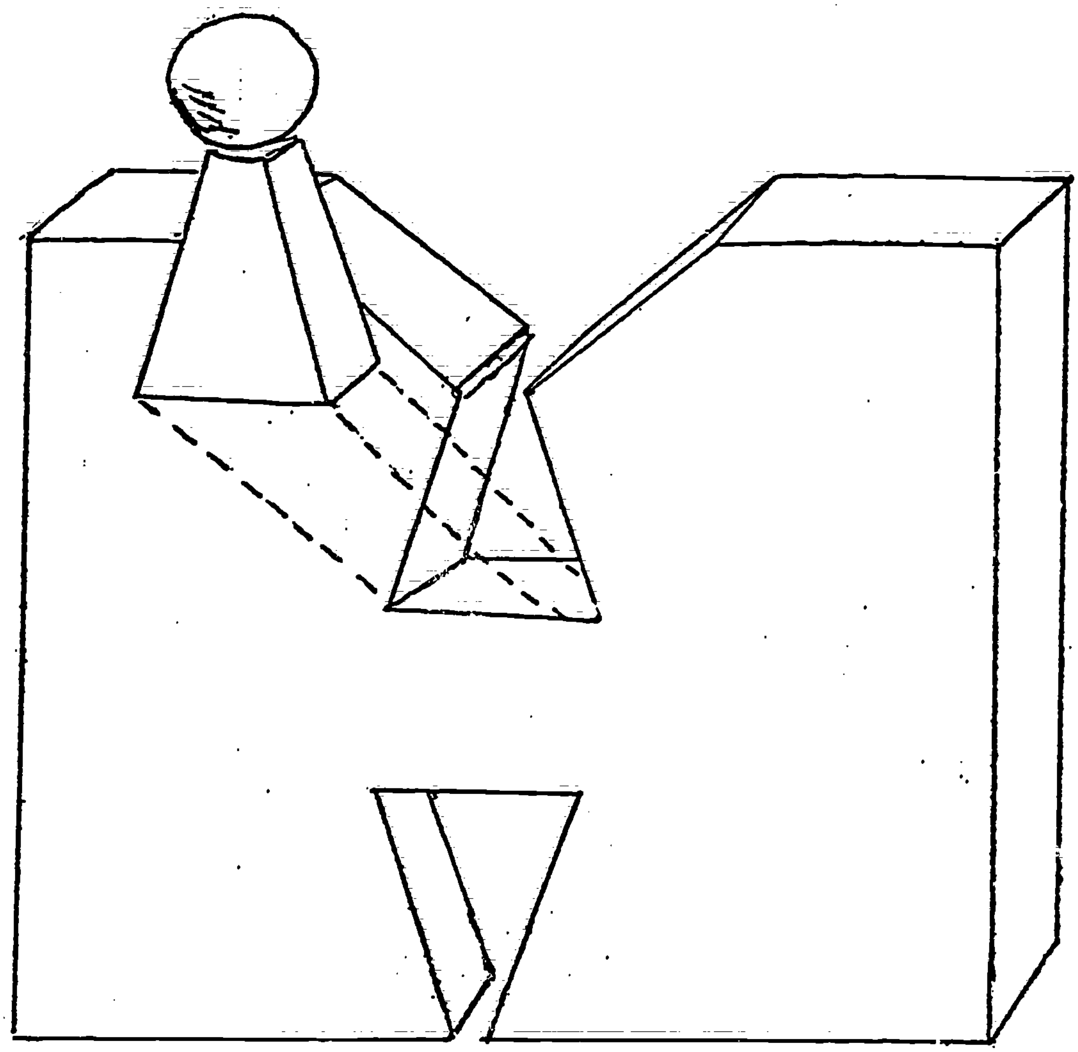
Production Steps: Type the terms to be contrasted at either end of the top of the page. Type a series of rating scales beneath the terms, with the quality to be rated below each scale.

Teaching Suggestions

1. The terms may be opposites or other related terms that are readily contrasted.
2. After the students have completed their ratings, the instructor may next explain his/her choices. However, there need not be a single best rating on any given quality.

(Refer to the example on the following page.)

MANIPULATIVE MODEL <u>re</u> THE STATES OF EQUILIBRIUM



RATING SCALE
ON QUALITIES OF TECHNICAL TERMS

ELASTICITY						PLASTICITY
1	2	3	4	5	6	7
			(temporary change)			
1	2	3	4	5	6	7
			(permanent change)			
1	2	3	4	5	6	7
			(flexible)			
1	2	3	4	5	6	7
			(rigid)			
1	2	3	4	5	6	7
			(deforms)			
1	2	3	4	5	6	7
			(recovers)			

VISUAL ANALOGY TO COMPARE THE LAY AND TECHNICAL USES OF A TERM

Purpose: Device to clarify and have students recognize the existing similarities between the physics and everyday uses of appropriate dual-meaning terms (e.g., momentum).

Description: Two pairs of pictures and two pairs of free body diagrams are drawn to depict the visual analogy. In one pair, people of equal mass are moving at different velocities, with greater momentum being associated with the greater velocity. In the other pair of pictures and diagrams, two vehicles of unequal mass proceed at the same velocity, with greater momentum being associated with the greater mass.

Learning Principle: Learning is facilitated by the assimilation of new knowledge into previously learned information.

Time Required for Use: 3 minutes

Preparation

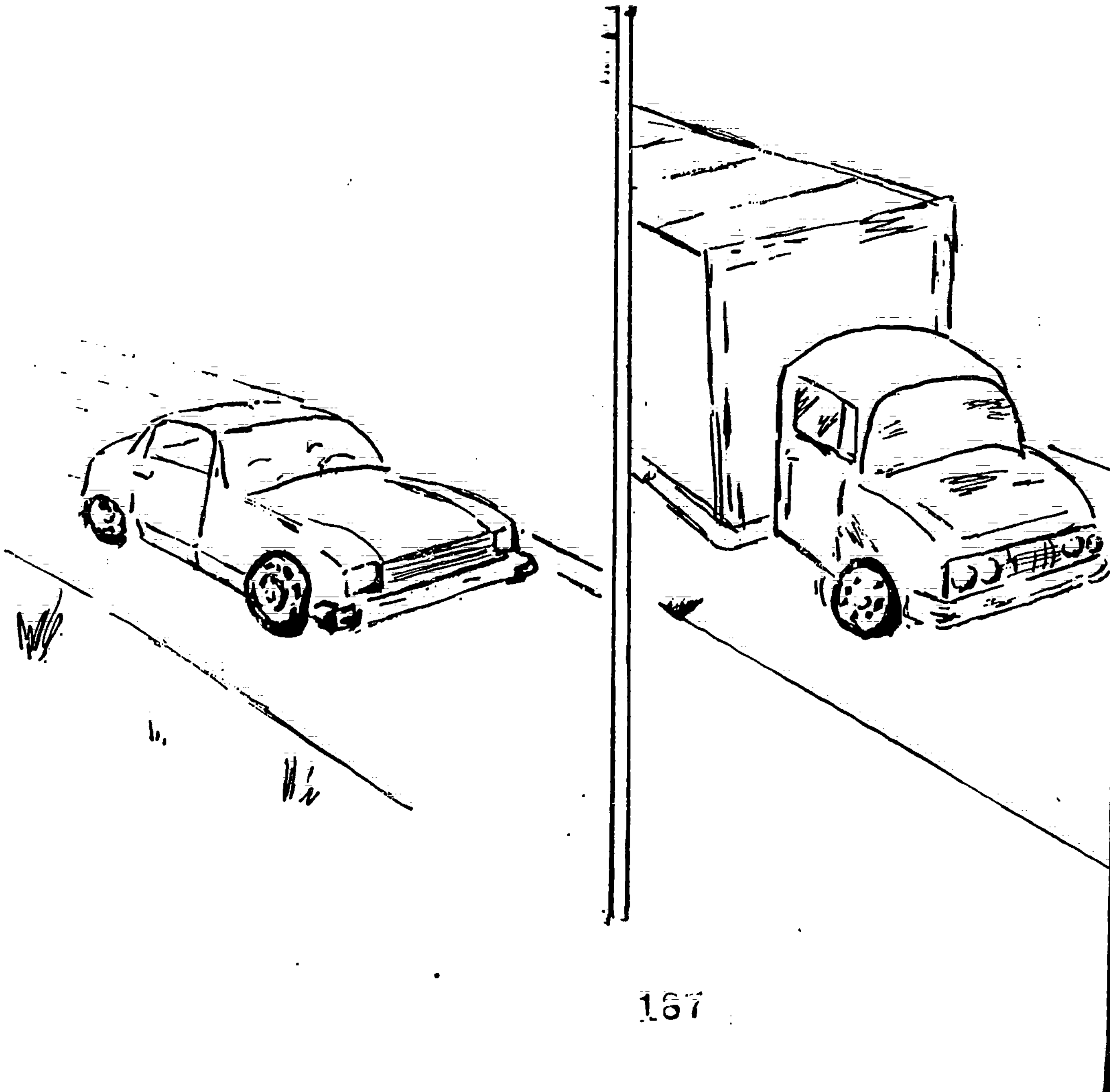
Materials Required: ...tures or overhead transparencies.

Production Steps: Pho... raph, draw, or reproduce (see following four pages) pictures and diagrams on the medium of choice, each on a separate page.

Teaching Suggestions

1. After momentum has been defined, present the pictures and diagrams, and ask the students which illustrated entity has greater momentum.
2. Emphasize the manner in which the measurement of momentum as defined coincides with the everday, intuitive concept of momentum.
3. The similar pairs of pictures and diagrams may also be effectively presented on the same page instead of on separate pages.

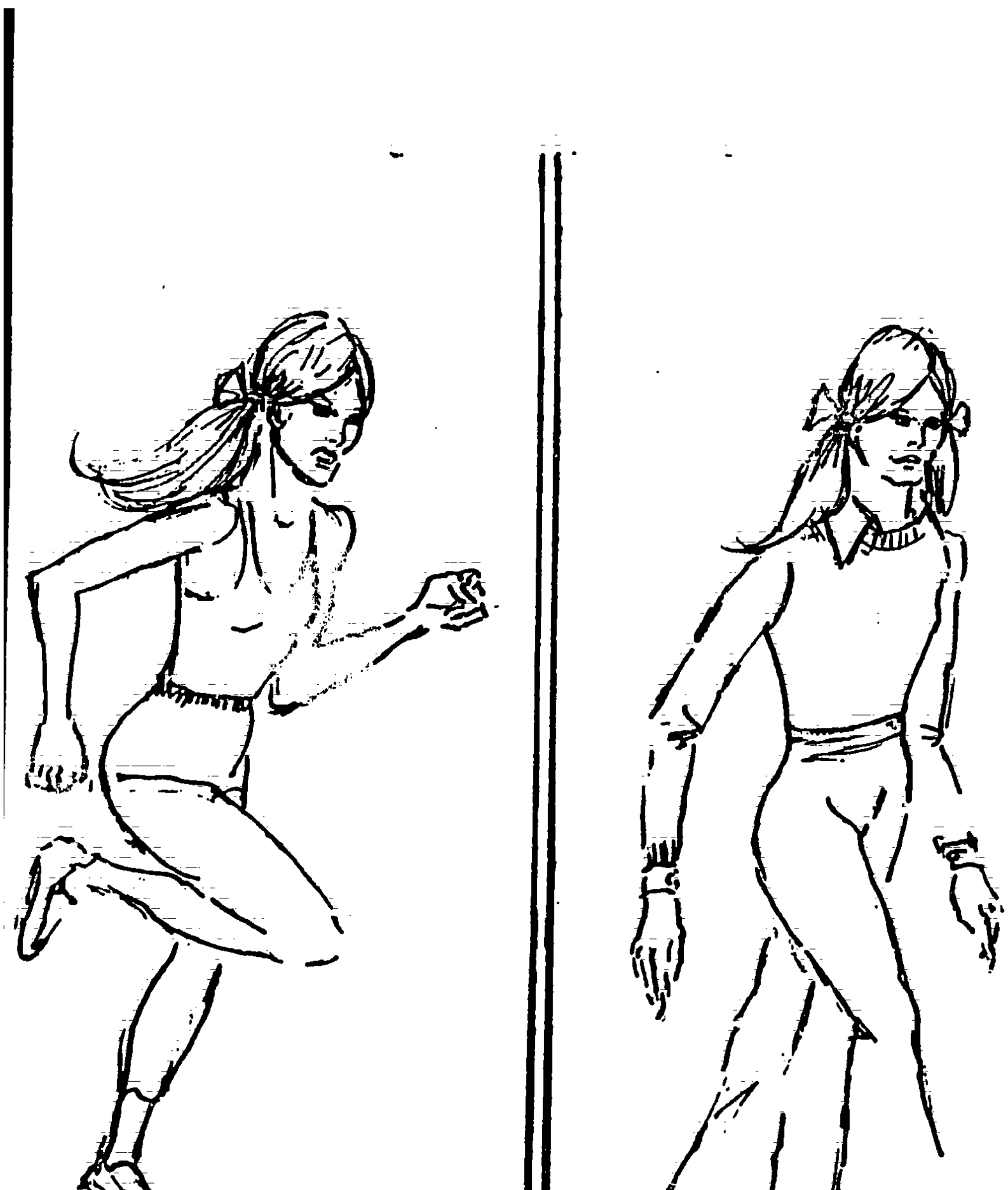
(See illustrations on the next four pages.)



$$\boxed{M_1} < \boxed{M_2}$$

$$\vec{V_1} = \vec{V_2}$$

$$P_1 \quad ? \quad P_2$$



$$\boxed{M_1} = \boxed{M_2}$$

$$\vec{V}_1 > \vec{V}_2$$

$$P_1 \quad ? \quad P_2$$

ILLUSTRATED QUESTION

SEQUENCE TO DEVELOP CONCEPTS

Purpose: A device to clarify the distinctions between the dual meanings of a concept (*e.g.*, conservation of energy).

Description: After a concept has been introduced, the students are presented with a series of questions and accompanying illustrations. These questions contrast the lay and technical definitions of the concept, leading to the clarification of the distinctions between the definitions on the part of the students.

Learning Principle: Differences between concepts are clarified by contrasting specific features.

Time Required for Use: 10-15 minutes

Preparation

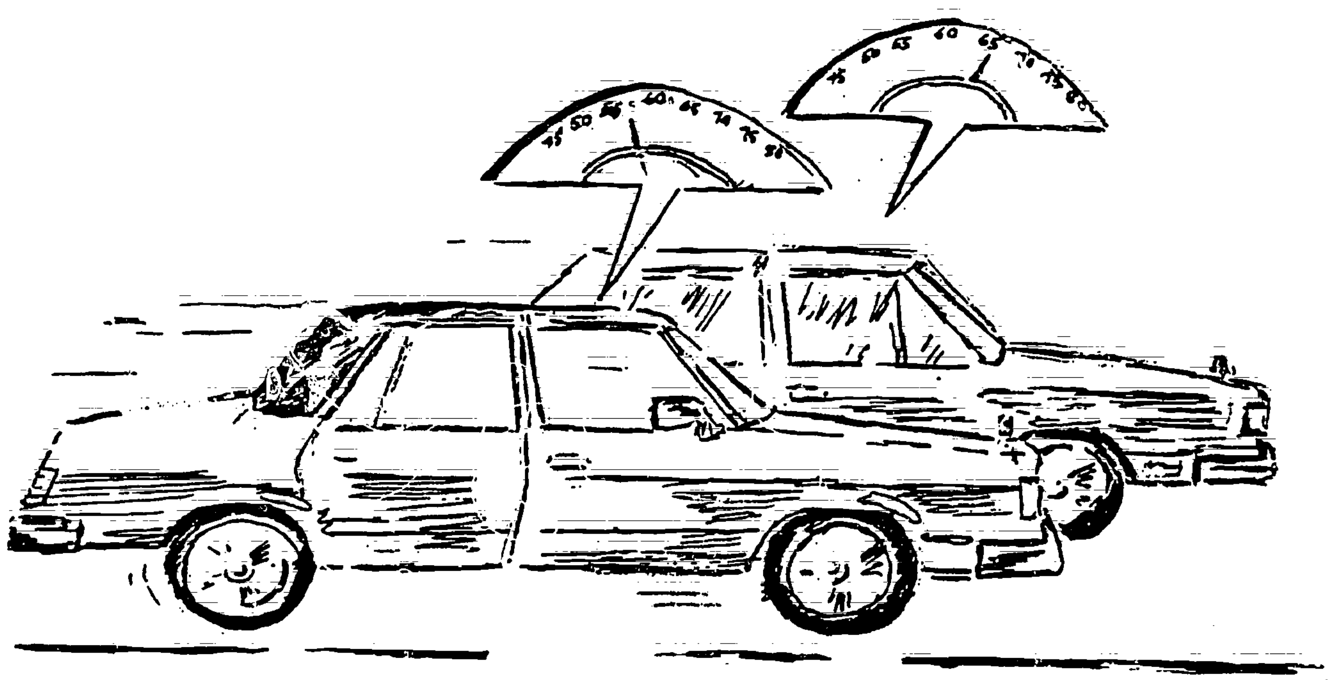
Materials Required: Overhead transparencies or series of pictures for use on an opaque projector.

Production Steps: Draw or reproduce the accompanying pictures and questions on medium of choice.

Teaching Suggestions

This device is appropriate for use with groups of any size. The questions may be used to determine student comprehension of the concept prior to or following its introduction.

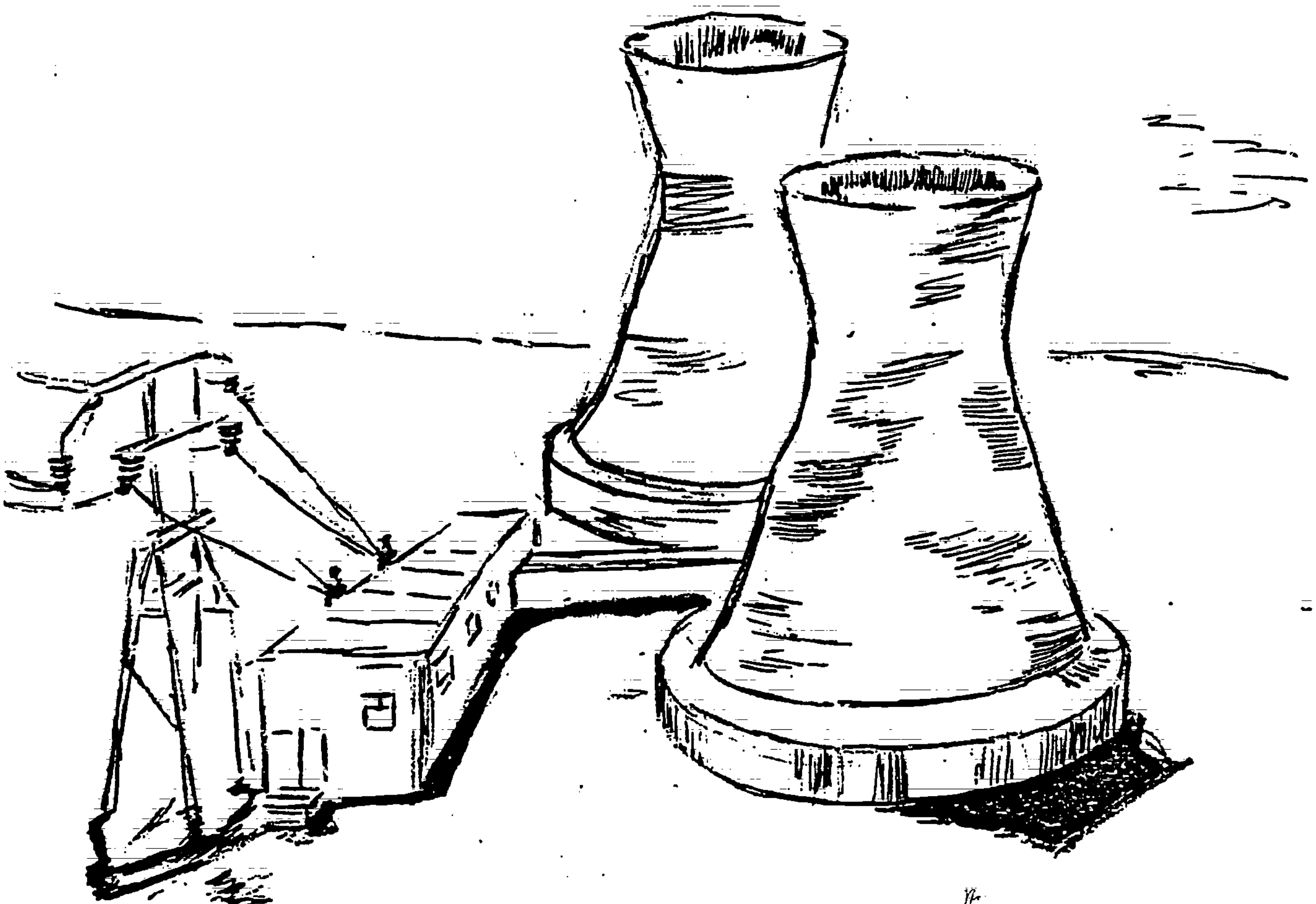
(Refer to the illustrations on the following page.)



Which of the following items demonstrates the law of the conservation of energy?

1) Driving more slowly to use less fuel.

2) The burning of gasoline in an internal combustion engine to power a car.

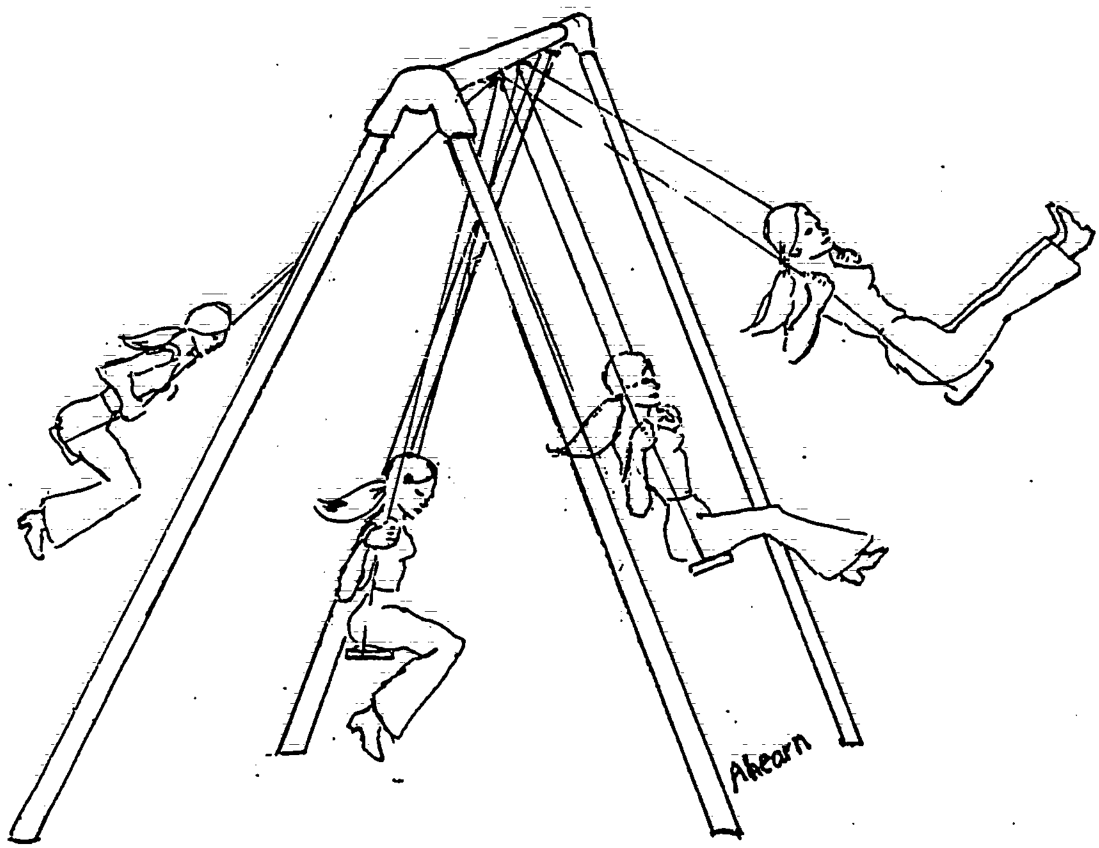


Which of the following items demonstrates the law of the conservation of energy?

1) A nuclear powered plant is built to generate electricity instead of a coal or petroleum fired plant.

2) Electric power is the end result of a process that begins with nuclear fission.

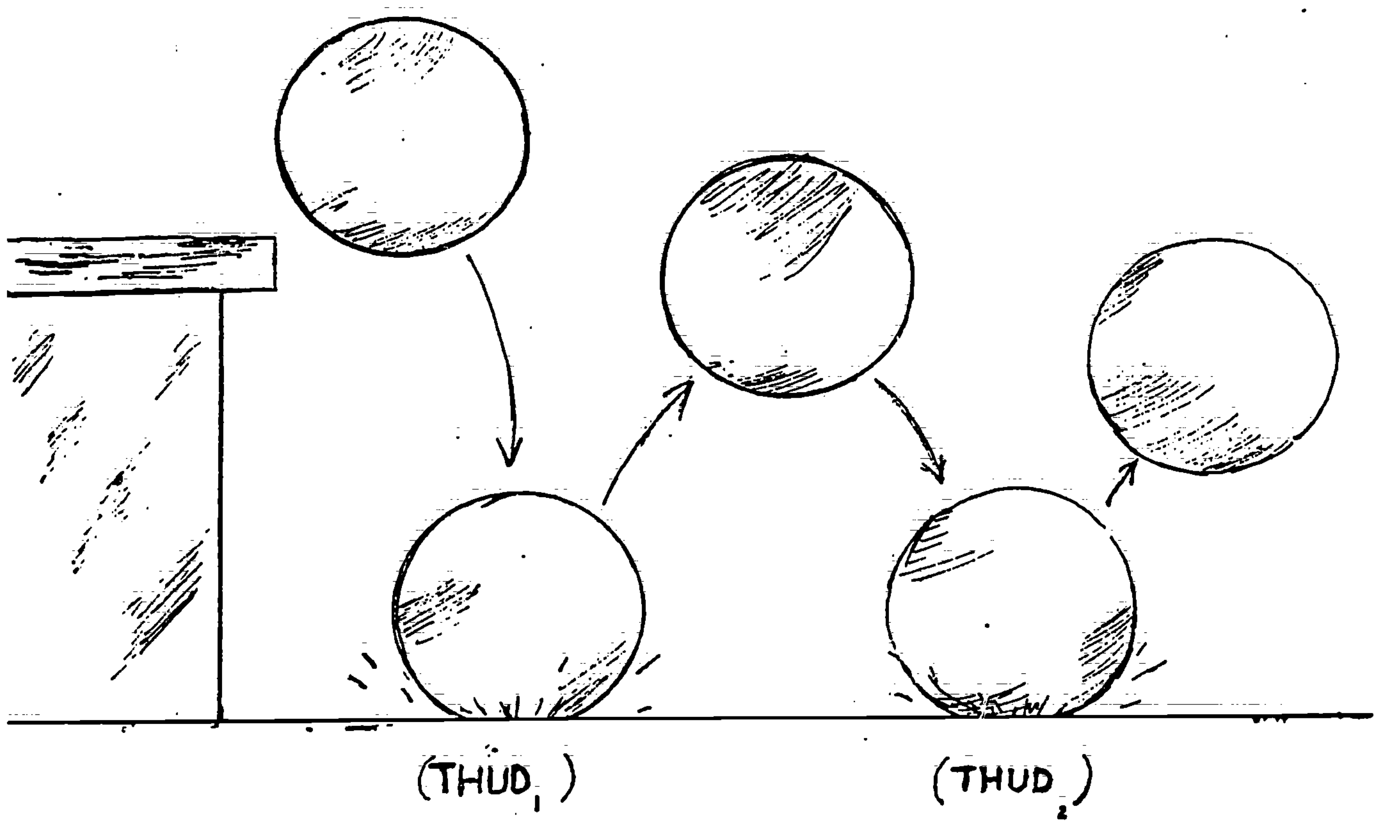
3) The heat released from a nuclear power plant may cause environmental damage.



Which of the following items demonstrates the law of the conservation of energy?

1) The pendulum-like motion of a person who is swinging.

2) Instead of continually propelling yourself, you sit still and let the swing carry you.

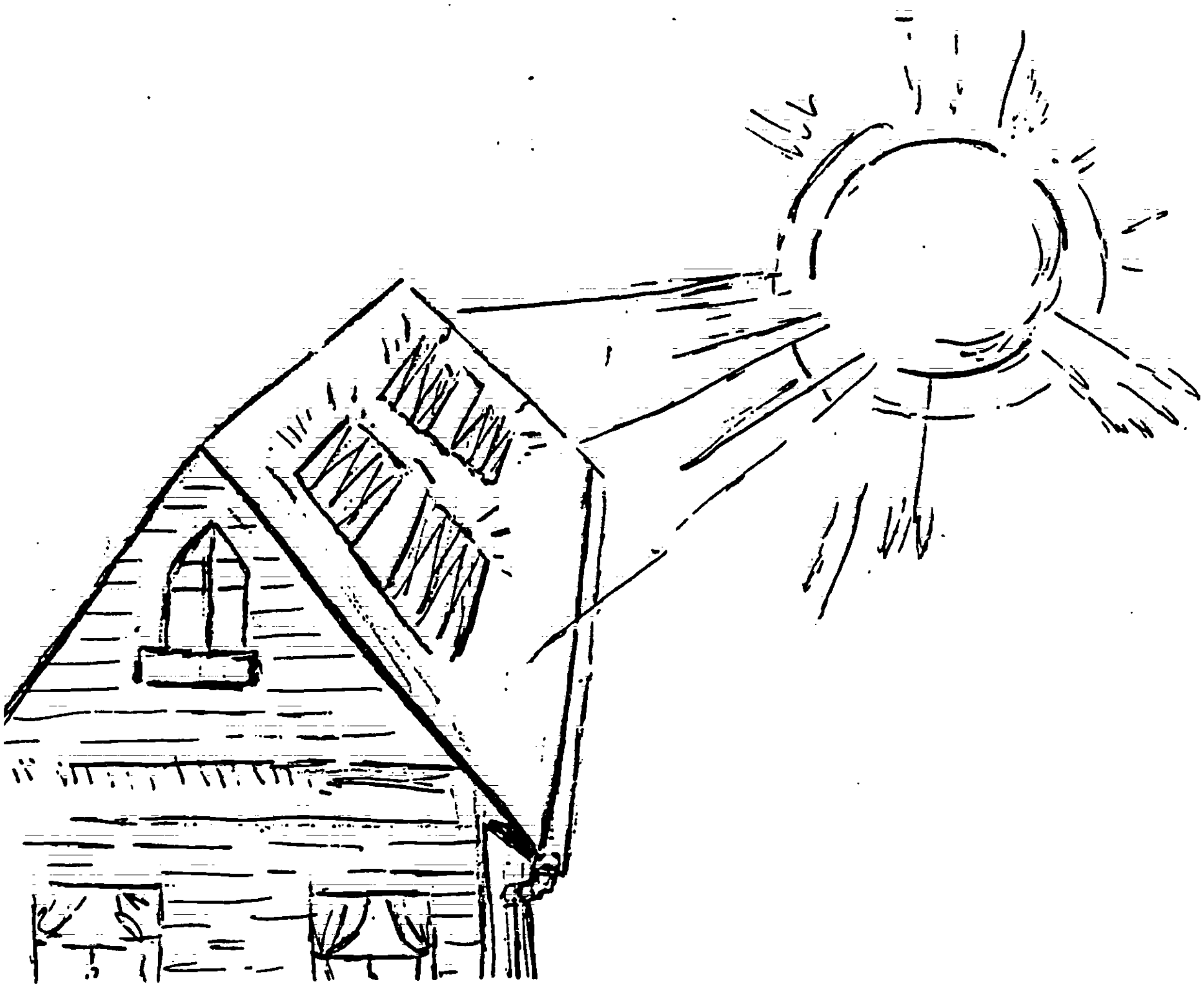


Which of the following items demonstrates the law of the conservation of energy?

1) A ball is dropped but it doesn't bounce back up as high as the point from which it has dropped.

2) You can hear the sound that the ball makes as it bounces.

3) Yo" can feel the vibration in the floor as the ball bounces.

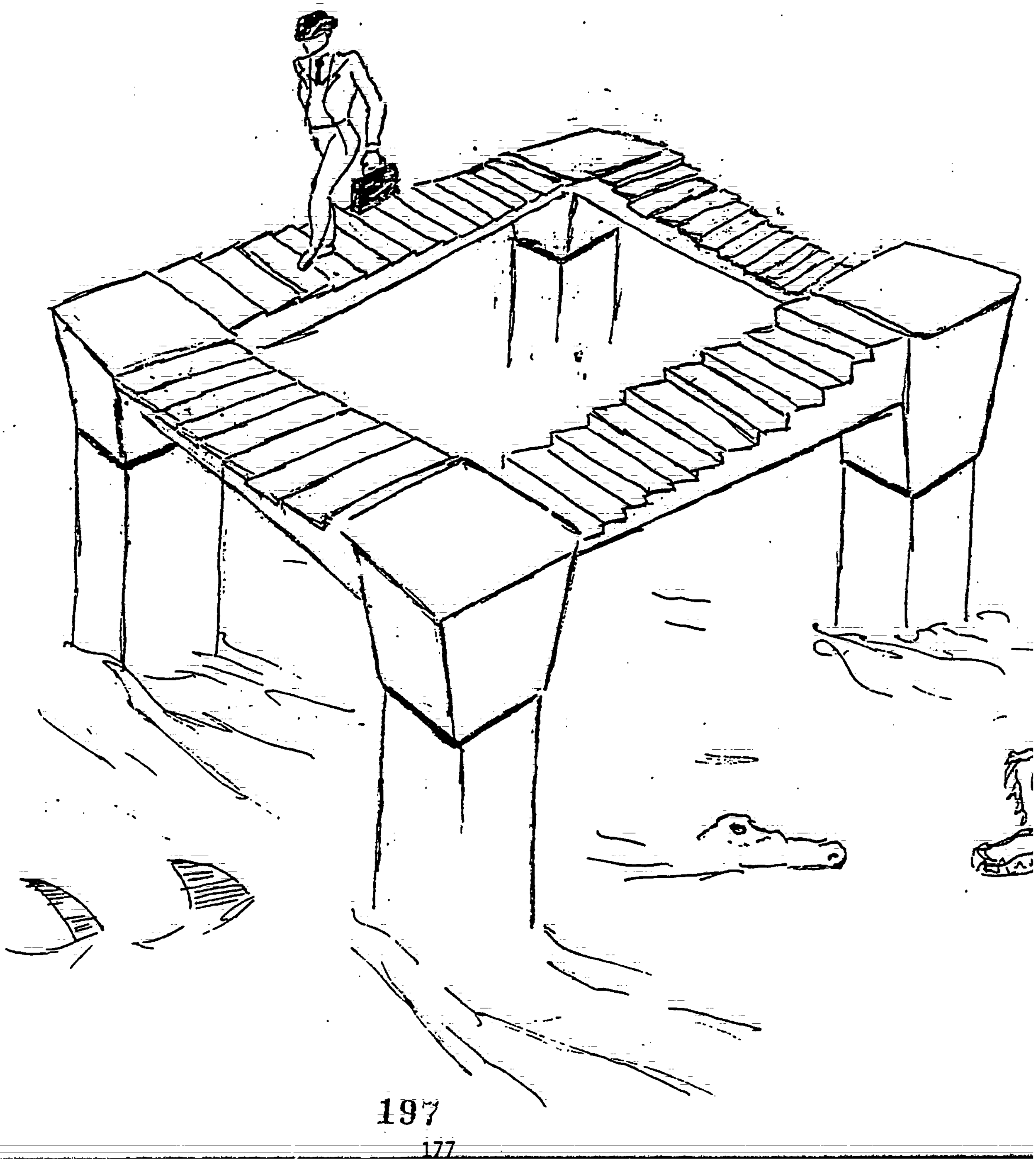


Which of the following items demonstrates the law of the conservation of energy?

1) A homeowner installs solar heat panels to decrease her furnace usage.

2) The solar panels convert solar radiation to hot water.

If a perpetual incline such as this could be constructed, would persons walking up (or down) the steps be adhering to the law of the conservation of energy?



RACING ROLLERS TO

DEMONSTRATE RELATIONSHIPS AMONG MOMENTUM, ROTATIONAL ENERGY, AND TRANSLATIONAL ENERGY

Purpose: A device to demonstrate the dependence of acceleration upon moment of inertia and the distribution of kinetic energy between rotation and translation.

Description: Two tin cans of the same mass, one with a copper core, the other with a wooden core are placed, side by side at the top of a wooden ramp. The cans are released and both roll down the ramp with different accelerations. The cans continue up another ramp and despite their difference accelerations, the moment of inertia allows the cans to reach the same height.

Learning Principle: Understanding can be attained through first-hand experience.

Time Required for Use: 10 minutes

Preparation

Materials Required: Two tin cans (of equal size)
Roll of pennies or roll of B.B.'s
Dowel the length of the can
2 wooden incline ramps
Stop watch
Balance
Bags of cedar shavings
Bag of B.B.'s

Production Steps: Prepare two tin cans, one with a roll of pennies surrounded by wood, the other with wood core, surrounded by B.B.'s. (Make masses equivalent)

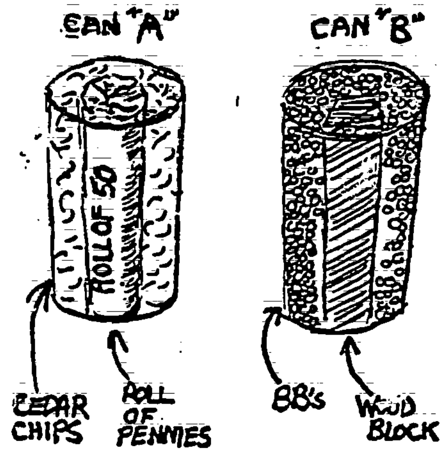
Teaching Suggestions

1. Note that in external appearance, the two cans are identical and a balance will show they have the same mass; but they roll with different accelerations dow the same inclined plane.
2. Have the students predict which can will reach the bottom of the ramp first (or will they take the same amount of time).
3. Ask the students why the can with the lead core always wins the race down the ramp? When both cans roll <u>up</u>, why do they reach the same height?

4. Discuss the distributions of kinetic energy in translation and rotation.
5. Discuss the dependence of acceleration, both upon the moment of inertia and upon the distribution of kinetic energy between rotation and translation.
6. Repeat the demonstration as required during steps four and five.

(Refer to the following illustration)

RACING ROLLERS TO DEMONSTRATE RELATIONSHIPS AMONG MOMENTUM, ROTATIONAL ENERGY, AND TRANSLATIONAL ENERGY



VISUAL CONTRAST OF LAY AND TECHNICAL USES OF A TERM

Purpose: Device to clarify purpose differences between the technical physics definition and the everyday use of a term (e.g., work).

Description: Three pairs of illustrations are produced, each composed of a realistic picture and a free body diagram* that corresponds to the picture. Two of these pairs accurately portray the physics definition of work, and one pair does not.

Learning Principle: Concepts are clarified by contrastive comparisons.

Time Required for Use: 5-7 minutes

Preparation

Materials Required: Opaque pictures or overhead transparencies

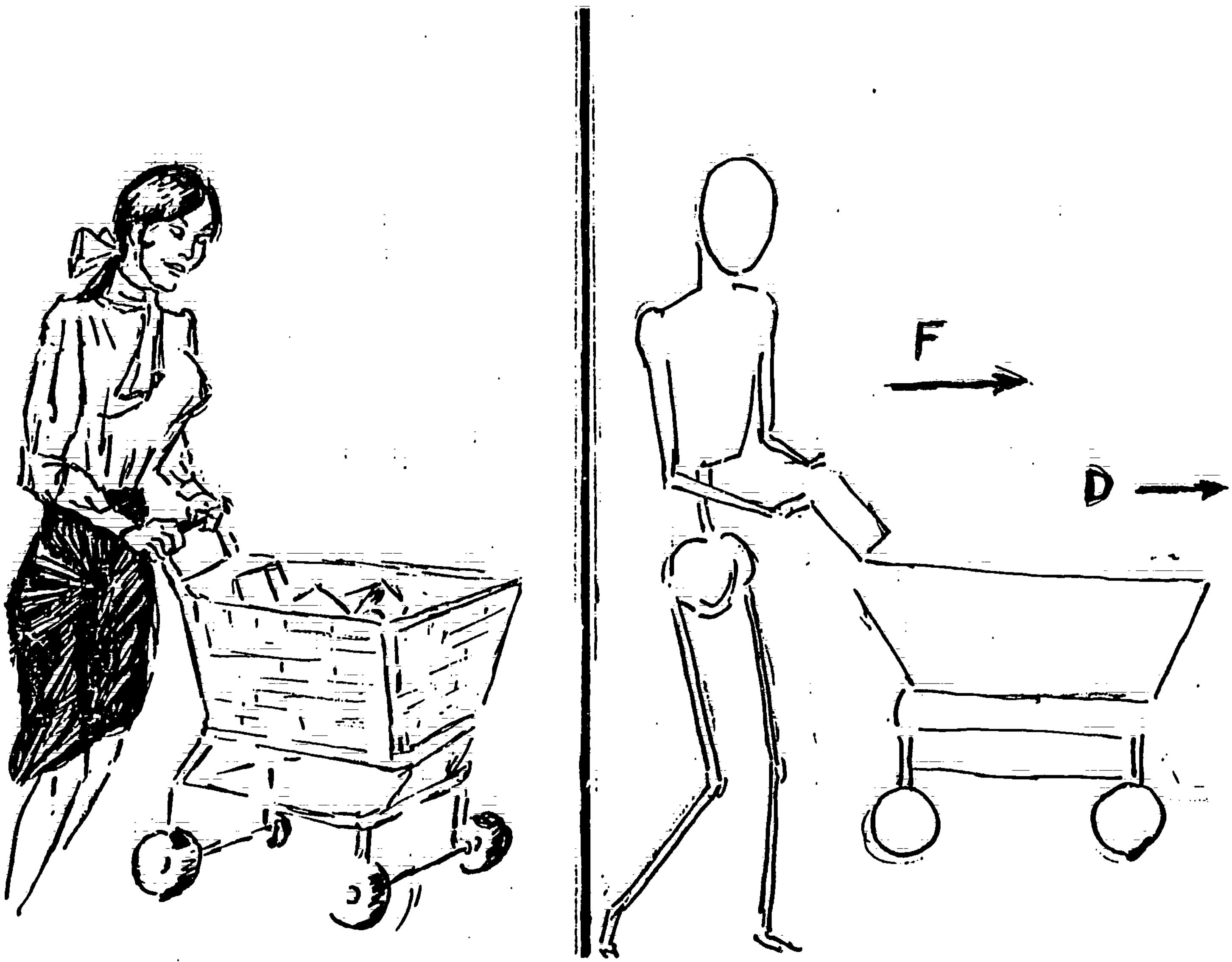
Production Steps: Draw or reproduce the pictures and diagrams on the medium of choice.

Teaching Suggestions

1. Once a definition and a formula for work have been given to the students, present the illustrations and ask whether or not the term is represented in its accurate physics context. Class discussion should follow and a formal explanation given to the students.
2. Projected transparencies may be used with any size class, while the opaque pictures are limited to use with small groups.

*For readers from disciplines other than physics, a free body diagram is a simplified diagram used to quickly analyze the pertinent elements of a problem.

(See the illustrations on the next three pages.)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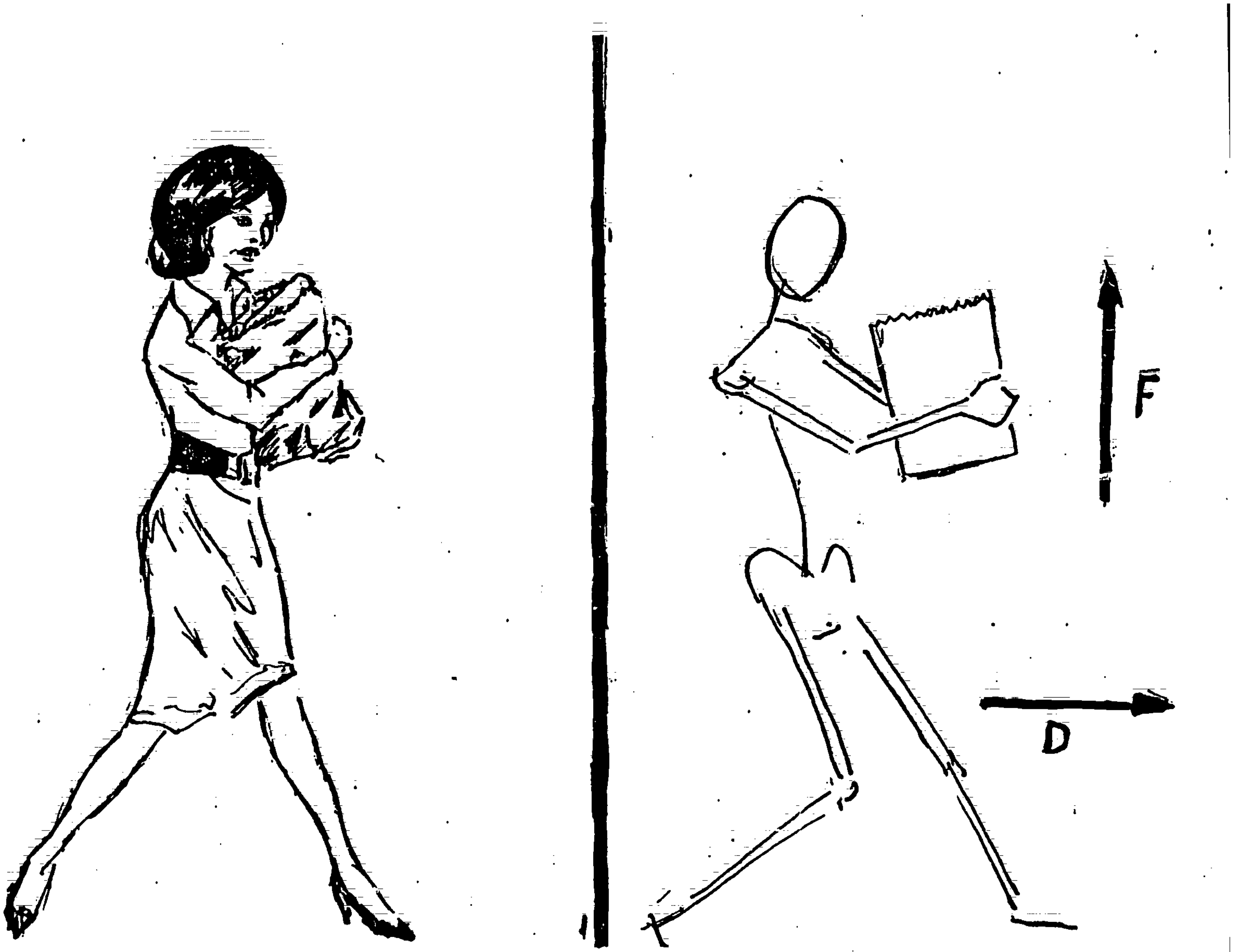

F
D

SEMANTIC DIFFERENTIATION OF THE PROPERTIES OF A TERM

Purpose: A device to define the semantic boundaries of a term (e.g., fluid).

Description: The target term is listed at the top of a transparency or handout sheet. Pairs of qualities that are polar opposites are then listed at each end of scales with seven intervals. The students select the point between the polar qualities that best describes the term by writing a "B" in the space at the appropriate interval on the scale. Through this process, the students indicate the degree to which each preferred quality is a good descriptor of the term.

Learning Principle: Analytical thinking promotes understanding.

Time Required for Use: 5 minutes

Preparation

Materials Required: Handout sheets
Transparency for overhead projection, or chalk and chalkboard

Production Steps: Type the term at the top of the page, with the semantic differential scales beneath. Transfer to the transparency if desired.

Teaching Suggestions

1. The instructor should review the students choices and also describe her choices, but she must keep in mind that there need not necessarily be one best answer (the technique is facilitative, not absolute).
2. The students may also select the polar quality that is the worse descriptor of the term, and indicate the degree to which it does not apply to the target term by writing a "W" in the space at the appropriate interval on the scale.
3. This scale may be presented in a large group lecture, completed for homework, and discussed in a small group situation (or any appropriate combination of these uses).

(Refer to examples on the following page.)

F L U I D

Stationary	____ :	____ :	____ :	____ :	____ :	____ :	____	Moving
Fixed	____ :	____ :	____ :	____ :	____ :	____ :	____	Changing
Smooth	____ :	____ :	____ :	____ :	____ :	____ :	____	Rough
Contained	____ :	____ :	____ :	____ :	____ :	____ :	____	Free
Adaptable	____ :	____ :	____ :	____ :	____ :	____ :	____	Rigid
Stubborn	____ :	____ :	____ :	____ :	____ :	____ :	____	Pliable
Liquid	____ :	____ :	____ :	____ :	____ :	____ :	____	Solid
Solid	____ :	____ :	____ :	____ :	____ :	____ :	____	Gas

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

P O W E R

Rate	____ :	____ :	____ :	____ :	____ :	____ :	____	Amount
Force	____ :	____ :	____ :	____ :	____ :	____ :	____	Energy
Magnitude	____ :	____ :	____ :	____ :	____ :	____ :	____	Time
Energy Transformed	____ :	____ :	____ :	____ :	____ :	____ :	____	Energy Conserved
Potential Energy	____ :	____ :	____ :	____ :	____ :	____ :	____	Kinetic Energy
Momentum	____ :	____ :	____ :	____ :	____ :	____ :	____	Work

DEMONSTRATION WITH QUESTIONING TO CONTRAST RELATED CONCEPTS

Purpose: A technique to demonstrate the ideas underlying a set of concepts, so that the students have an experiential base upon which to build their technical vocabulary (e.g., heat, temperature, and internal energy).

Description: Two metal solids (one twice the mass of the other) are heated to 100°C in boiling water. Remove the solids from the water, have students feel the air around the solids, then repeatedly measure the temperature of the air and of the solids over a period of time. Contrast (1) heat as being the transfer of energy to the air and your hand, with (2) internal energy as the total energy of the molecules, and (3) temperature as the measure of the average kinetic energy of the molecules. This demonstration will show how the object with the greater mass has greater internal energy, that is the object remains warmer for a longer period of time.

Learning Principle: First-hand experience facilitates learning.

Time Required for Use: 20 minutes

Preparation

Materials Required: Burner, flask, water, metal solids (i.e., cubes, balls).

Production Steps: Obtain solid objects, purchase and assemble other utensils.

Teaching Suggestions

Socratic questioning is best used in a small group teaching situation. Questions such as the following may be used:

A. (re heat)

1. What is the warmth that you feel?
2. Why do you feel the warmth in the air around the solids?
3. If you would touch the solids, why would you feel the warmth more intensely?
4. Is heat something that is in the solids or something that is transferred from them?

B. (re internal energy/thermal energy)

1. Which solid will stay warmer for a longer period of time?
2. If a solid has twice the mass (2x as many molecules) will it be twice as hot?
3. Does it have twice the internal energy?
4. Does it have twice the thermal energy?

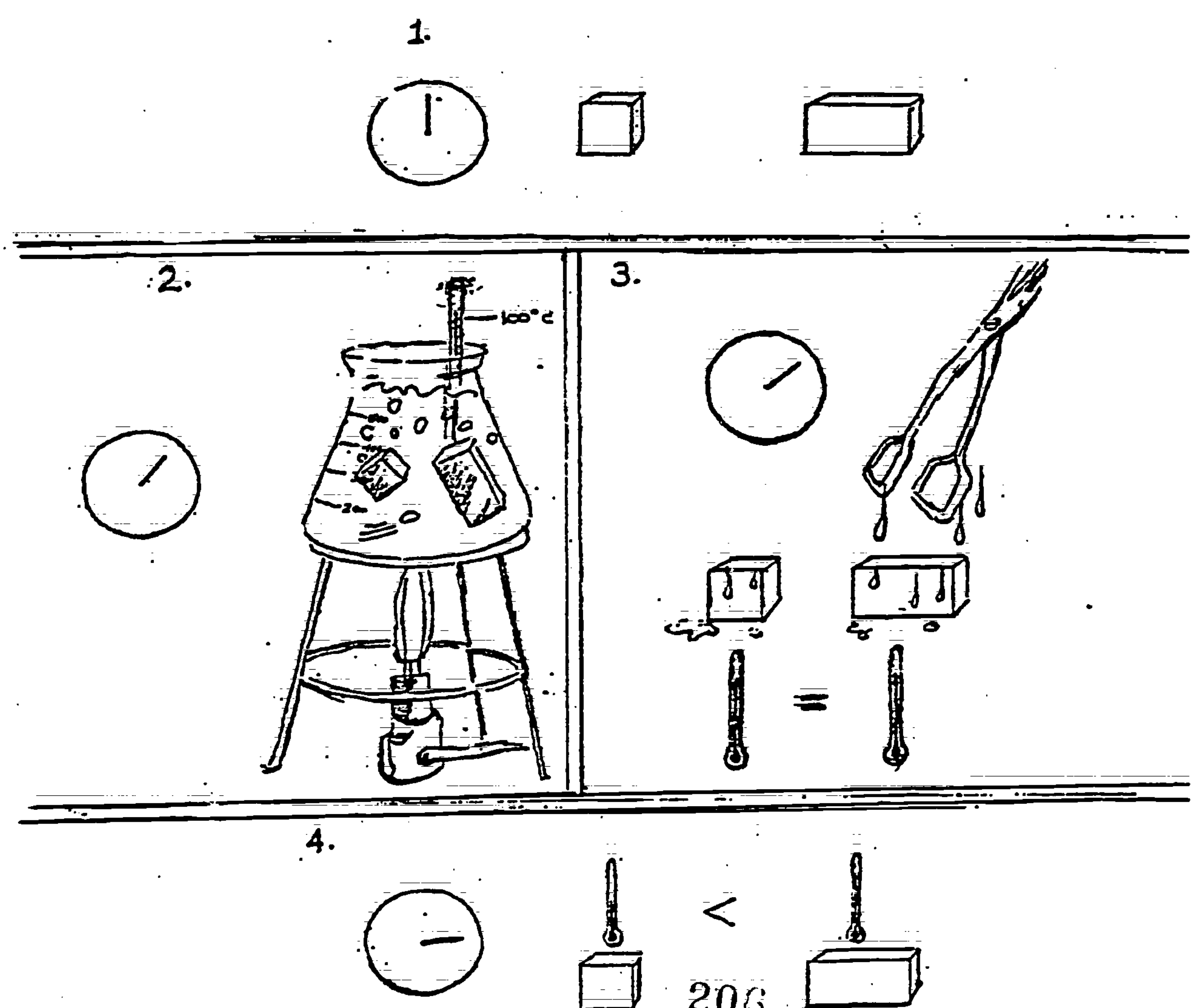
C. (re temperature)

1. How do you measure the thermal/internal energy of an object?
2. How do you measure the total kinetic energy of the molecules in an object?
3. How do you measure the average kinetic energy of those molecules?

(Refer to the following illustration)

DEMONSTRATION TO CONTRAST

HEAT, TEMPERATURE, AND INTERNAL ENERGY



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JAMES AHERN

PAIRED COMPARISON TECHNIQUE
FOR CONCEPT CLARIFICATION

Purpose: A technique to facilitate student classification of concepts and vocabulary, used either:
(1) as a pre-lecture advance organizer, or
(2) as a post-lecture synthesis

Description: A list of related terms from a given section of content is presented for pair by pair contrast to determine whether each term is superordinate, equivalent, or subordinate to every other term. The end result is a hierarchically ranked list of terms.

Learning Principle: Making fine distinctions sharpens the students' thinking.

Time Required for Use: 15 minutes

Preparation

Material Required: Choice of: chalkboard/chalk, or
handout sheets, or
transparency with marking pens

Production Steps: Select terms that are similar but differ in degree for comparison and present via medium of choice.

Teaching Suggestions

1. Best used in small group lecture or discussion sections.
2. May be used in conjunction with a structured overview or other organizational device.
3. Alphabetizing the original list of terms and manipulating the letters instead of words (e.g., $A=B$, $B>C$, $C \leq D$) may facilitate the comparison process.
4. Depending upon the membership of the class, it may be necessary to define the following general vocabulary terms: superordinate, equivalent, or subordinate. The following mathematical symbols may also need to be taught: $=$, $>$, $<$, $\geq$, $\leq$ and $\cong$.

(Refer to example on the following page.)

PAIRED COMPARISON TECHNIQUE

Terms given:

A. Electric charge

B. Positive

C. Negative

D. Insulator

E. Conductor

F. Semiconductor

G. Electroscope

H. Coulomb's Law

I. Dielectric constant

J. Electrometer

Paired comparison (letter/symbol technique is optional)

$A > B, C, D, E, F, G, I, J$	$A \angle H$
$B=C \geq D, E, F, G,$	$B, C < H$
$D=E-F \cong G, J > I$	$D, E, F < H$
$G=J \angle H$	$G, J > I$
$H > I$	

Final hierarchy:

1. (H) Coulomb's law
2. (A) Electric change
3. (B) Positive
   (C) Negative
4. (D) Insulator
   (E) Conductor
   (F) Semiconductor
5. (G) Electroscope
   (J) Electrometer
6. (I) Dielectric constant

INDUCTIVE APPLICATION OF PRINCIPLES

Purpose: A device which challenges the students to predict consequences, explain and support hypotheses, and verify predictions (e.g., for a siphon).

Description: A transparency with a list of principles pertinent to fluid pressure is shown to the students, followed by a series of illustrations or overlays showing various arrangements of a siphon, two flasks, and the fluid within these containers. The variations include depictions of 1) the flasks at different relative heights, 2) different fluid levels within the flasks, and 3) an empty vs. a full siphon tube. The students are asked to predict the direction of fluid flow in each of the illustrated conditions, the reason for the fluid flow, the given principles which apply, and any other principles that may apply.

Learning Principles: The application of a principle aids in its understanding and retention.

Time Required for Use: 10-15 minutes.

Preparation

Materials Required: Thermal transparencies

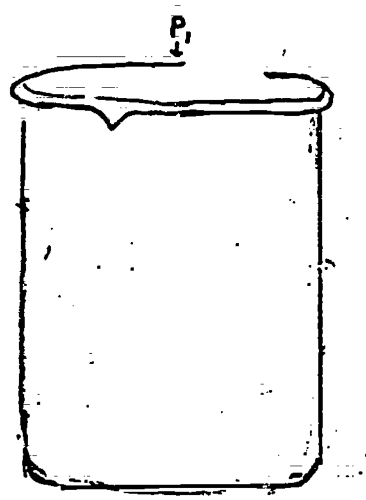
Production Steps: Draw or reproduce the lists of principles and illustrations shown on the following pages. The base transparency will be used with two sets of overlays (1-4 and 5-6). After making xerox copies of the overlay pages there are two options in developing the thermal transparencies: (1) A transparency can be made of the manual page and then cut along the broken line to form two overlays or (2) the xerox copy can be cut along the broken line and a full size thermal transparencies can be made for each overlay.

Teaching Suggestions

1. This technique is adaptable to a large lecture or small group presentation.
2. Verify the workable and nonworkable siphon arrangements for the students, and also state which principles accurately apply to siphon function.

(Refer to the illustrations on the following four pages.)

Base Transparency



$P = \frac{F}{A}$

$P = \rho g h$

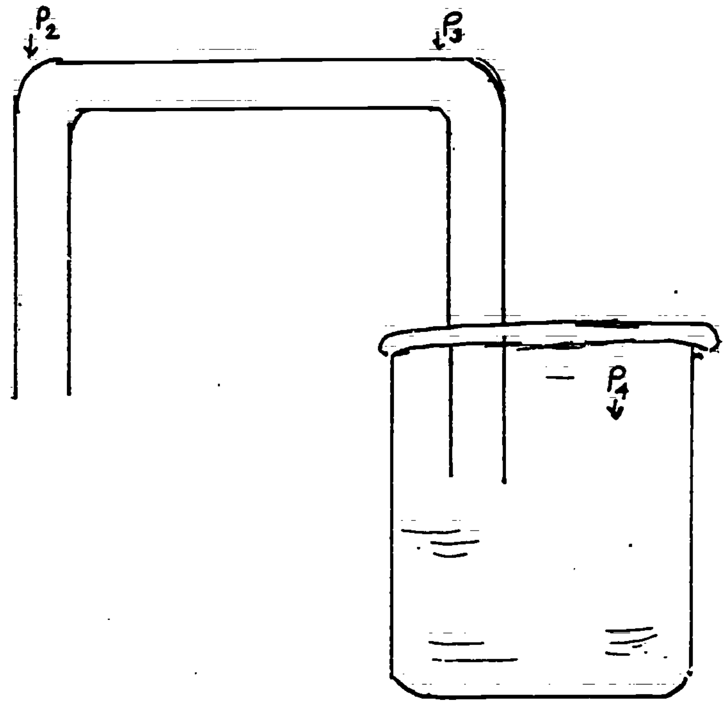
Pascal's Principle: The pressure applied to a confined fluid is transmitted throughout the fluid and acts in all directions.

Archimedes' Principle: The buoyant force on a body immersed in a fluid is equal to the weight of the fluid displaced by that object.

Pressure head = height (h)

Force due to fluid pressure always acts perpendicularly to any surface with which it is in contact

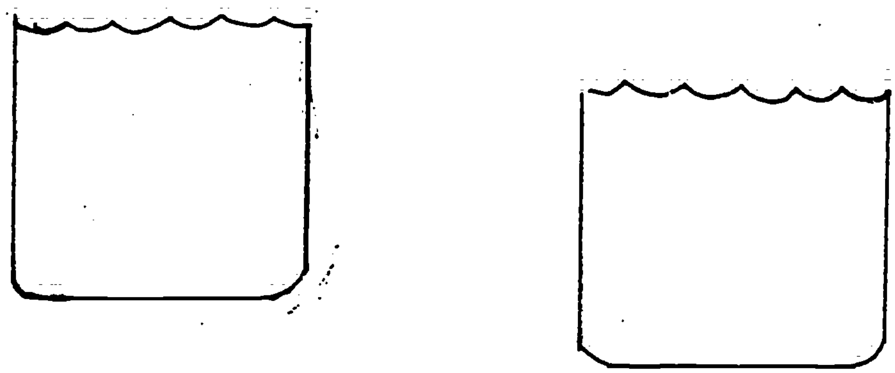
Overlay Number 1



The second
flask is lower
than the first.

Overlay Number 2

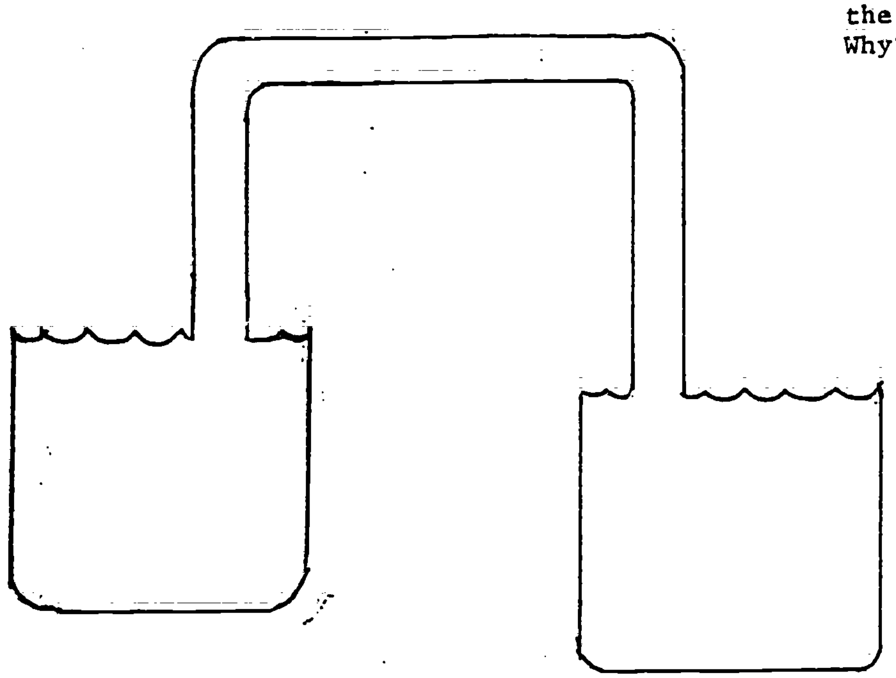
There is no fluid in the siphon tube.
What will happen? Why?



212

Overlay Number 3

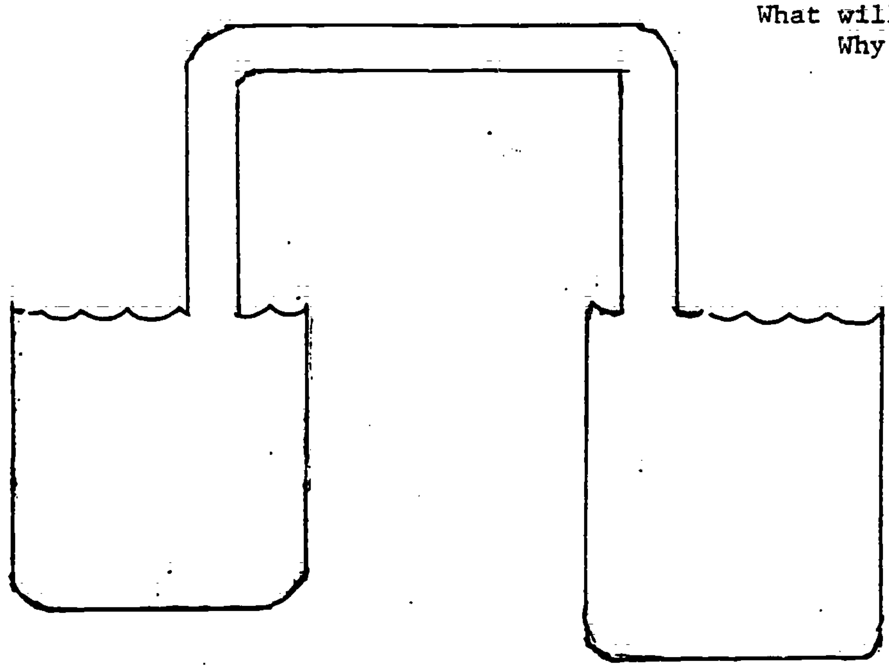
Fluid is in the siphon tube.
In which direction will
the fluid flow?
Why?



213

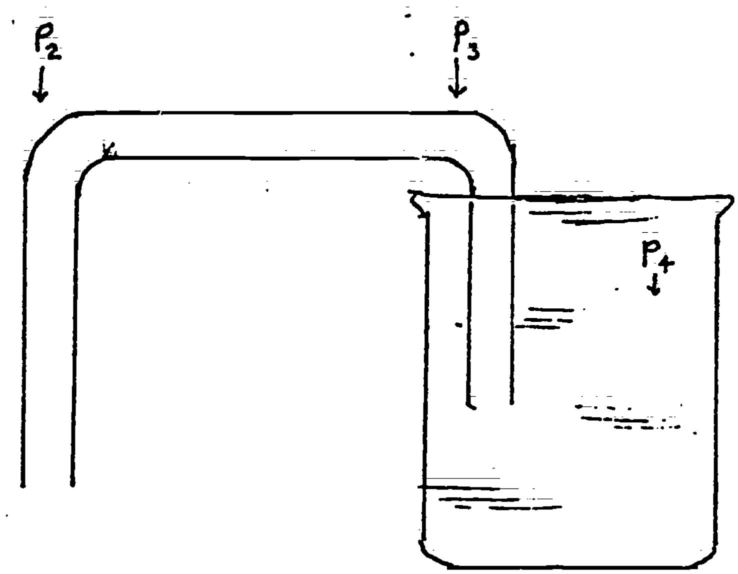
Overlay Number 4

The fluid levels are equal
and there is fluid in
the siphon tube.
What will happen now?
Why?



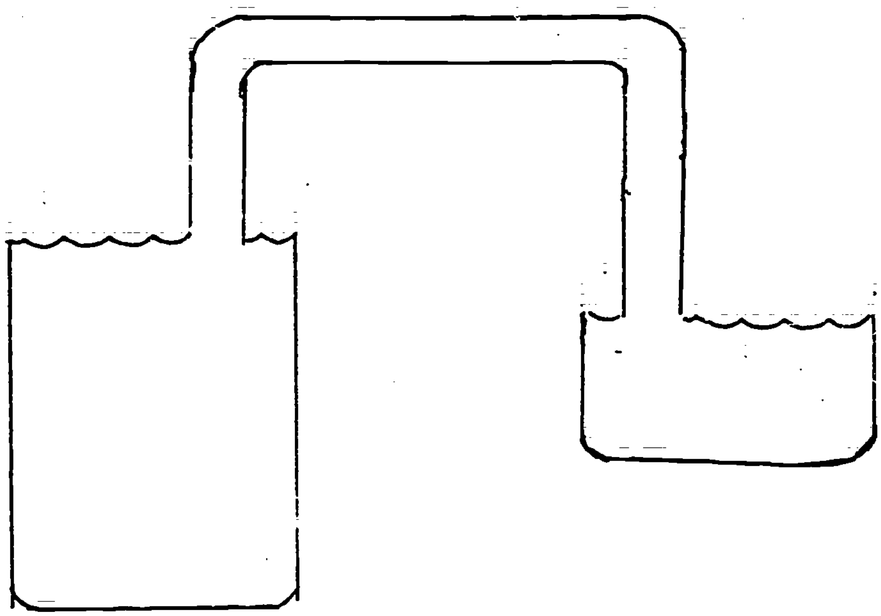
214

Overlay
Number 5



The second
flask is higher
than the first

Overlay Number 6



However, the fluid level is lower. In which direction will the fluid flow? Why?

FACULTY EVALUATIONS OF THE TECHNIQUES

During the Fall 1981 trimester of the investigation, while the Physics techniques were in the final development stages, these instructional techniques and devices were initially field tested in the weekly Language Study Group comprised of fifteen students from the Introductory Physics course. The evaluation ratings which were obtained during this period are reported here rather than ones from the winter trimester as planned. The cooperating Physics instructor during the winter trimester, a new faculty member, had some difficulty fitting the techniques and devices into the lecture period. Thus, a rather informal evaluation of each technique was completed by the Physics instructor. Rather than not reporting any student evaluation, it was decided to include those from the Fall 1981 trimester.

Evaluative information on three factors are tabulated below:

1. the percentage of the students listing the problem in their language logs
2. the percentage of the students reporting that the device solved their problems
3. the percentage of the students recommending that the device be used for instructional purposes.

Since the Language Study Sessions were held for only one hour per week. several of the techniques were not field tested or evaluated by the students. These techniques and devices were rated informally (RI) in the fall and winter trimester by members of the project team and by the cooperating professor.

Table 4

PERCENTAGES FOR STUDENT RATINGS OF TECHNIQUES

Instructional Techniques/Devices	Students listing problems in log	Students reporting problems solved	Students recommending use of device
Accordion Charts Presenting Varied Heuristic Strategies (Problem Solving)	60%	80%	100%
Peer Group Interaction to Induce a Set of Concepts	66%	100%	100%
Structured Summary Block Design	46%	69%	100%
Active Demonstration of Concepts (Acceleration, Impulse, Momentum, Displacement)	75%	75%	100%
Working Model to Demonstrate the Elements of Motion (Displacement, Velocity, and Acceleration)	100%	75%	87%
Device to Demonstrate Negative Acceleration	RI		

Instuctional Techniques/Device	Students listing problems in log	Students reporting problems solved	Students recommending use of device
Critical Attribute List to Define Technical Terminology (Mass)	44%	66%	88%
Pulley Truck Device to Demonstrate Newton's Second Law	RI		
Sketches of Alternate Definitions to Clarify Technical Meanings	33%	77%	88%
Pie-Chart Explanation of a Quantitative Term (Radian Angles)	42%	71%	57%
Mechanism to Demonstrate Newton's Law of Universal Gravitation	40%	80%	100%
Manipulable Depiction of Equivalent Forms (Kepler's Law)	13%	50%	50%
Etymological Charting of Technical Terminology (Moment)	64%	78%	78%
Pocket Chart to Portray Analogous Terms (Rotational Motion vs. Translational Motion)	77%	77%	100%
Manipulative Model to Contrast Terms (States of Equilibrium)	50%	75%	62%
Rating Scale to Differentiate Between Technical Terms (Plasticity vs. Elasticity)	60%	55%	65%
Visual Analogy to Compare the Lay and Technical Uses of a Term (Momentum)	46%	46%	75%
Illustrated Question Sequence to Develop Concepts (Conservation of Energy)	25%	88%	75%
Racing Rollers to Demonstrate Relationships among Momentum, Rotational Energy and Translational Energy	RI		
Visual Contrast of Lay and Technical Uses of a Term (Work)	RI		
Semantic Differentiation of the Properties of a Term (Fluid)	25%	50%	65%
Demonstration with Questioning to Contrast Related Concepts (Heat, Temperature, Internal Energy)	RI		
Paired Comparison Technique for Concept Clarification (Electricity)	25%	50%	62%
Inductive Application of Principles (Siphon)	28%	85%	85%

At least 20% of the students in this group indicated difficulty with each language problem for which a technique was prepared. This is reflected by percentages of students reporting problems in the log ranging from 13% (little difficulty) to 100% (more than average difficulty). Most of the students indicated that the devices and techniques clarified their problems. The percentages of students recommending use of the devices ranged from 57% (recommend use of device) to 100% (strongly recommend use of device) for instructional purposes. From these positive student evaluations it appears that the techniques and devices were viewed as an asset for helping the students overcome the learning difficulties encountered in the introductory physics course.

Because instructors find it difficult to utilize a great many new techniques in any one trimester or semester, it will take several terms for each interested faculty member to choose and assess the techniques that he or she wants to use. Consequently the full assessment of the techniques by several faculty members may take a number of years.

Chapter 7

RECEPTIVE LANGUAGE PROBLEMS

P H I L O S O P H Y

The numbers of reading and listening difficulties by experimental groups from introductory classes during two trimesters from Fall of 1980 through Spring of 1981 (Logic) and the Fall of 1981 (Great Traditions in Philosophy) were as follows:

	Total Problems	Serious Problems
Technical Vocabulary	77	37
General Vocabulary	36	10
Explanations of Principles and Generalizations	42	30
Metaphors of the Discipline.	3	3
Specialized Language Style Factors of the Discipline	5	5
Complex Sentence Structures.	5	5
Tabular and Graphic Presentations.	0	0

Any item that students mentioned as a difficulty was considered to be a problem, but an effort was made not to avoid including items merely because they were new. An item was considered to be a serious problem if it was classed as a difficulty by twenty percent or more of any group and if it could not be easily understood or answered by referring to the text or to another readily available source. Since most of the students at the University of Pittsburgh are from the upper forty percent of their high school classes, more problems might be listed as serious in colleges that admit a larger proportion of high school graduates. Surely one could expect more problems with sentence complexity among less competent students. Likewise, a smaller proportion of difficulties would be serious in a more selective school.

As might be anticipated, the largest number of difficulties was with technical vocabulary. Although the number of serious difficulties in explanations of principles and generalizations was not as great, failure to understand even a few such key items could result in very poor achievement for the student. It appears that metaphors and special language style factors may be used less frequently in introductory courses than is likely in more advanced courses.

The problems encountered in the experimental groups from the three classes in philosophy are itemized below. The classification of an item as technical vocabulary, general vocabulary, metaphor, etc., had to be based on somewhat subjective judgements, so other educators may prefer to classify some items differently. Those problems that seemed to be serious are starred.

TECHNICAL VOCABULARY IN PHILOSOPHY: THE DIFFICULTIES NOTED

*annotation
*arete (Plato)
*atomic statement
*catechuman (Augustine)
categorical sentence form
*closed branch
*closed tableaux
commutation
consequent
contingent
*contradictory
deduction
derivation
derivation line
distributed predicate
*equivalence
exclusive disjunction
*extension of the predicate
figure
finished tableaux
finished tableaux branch
force
*free association (Freud)
*guilt (Freud)
*happiness (Plato)
*id (Freud)
implication
*indirect proof
*libido (Freud)
Manicheanism (Augustine)
metatheorem
*mind as interaction of objects (Hobbes)
modus ponens
modus tolens
mood
monadic
*natural deduction
negative
*obtain/implication
Oedipus Complex (Freud)
open branch
open tableaux
*particular affirmative
*particular negative
polyadic
*polymorphus perversity (Freud)
*predicate variables
premiss
premiss bar
*psychoanalysis (Freud)
quantifiers
quasi-traditional rules
reducto ad absurdum
*reiteration strategy
*repetition strategy
rule of reiteration
rule of repetition
*rules of elimination
*rules of introduction
schematic representation
semantic predicate
semantic tableaux
sentential language
set up strategy
*splitting
*sublimation (Freud)
*subordinate
syllogism
syllogistic arguments
tilde
*truth functional
*universal affirmative
*universal negative
*use mention
*validity
*variable
*well formed formula

GENERAL VOCABULARY USED IN PHILOSOPHY: THE DIFFICULTIES NOTED

albeit
*antecedent
assert/assertion
association
benevolent
conjecture
deploying
*dialectics
discipline
disingenuous
*divers/diverse
*dogma
*ego
embody
illusory
inelegance
interlocutors
inference
omniscient
optimal translation
*peccadilloes
pragmatic
*purport
*putative
scrupulous
semantic
splitting
strategy
stymied
subordinate
superfluous
syntax
*truth
*vacuous
veridical
vexing

EXPLANATIONS OF KEY PRINCIPLES, GENERALIZATIONS, OR COMPLEX CONCEPTS IN PHILOSOPHY: THE DIFFICULTIES NOTED

*1. A compound is truth-functional when its truth value can be determined under all possible circumstances by the truth values of the components.

*2. Any assignment of truth to the variables of a well formed formula will determine the truth value of a well-formed formula.

3. The construction of a truth will determine the truth value of a well-formed formula.

*4. The validity of an argument (either symbolic or in English) is determined by the truth values of its premisses and its conclusion.

*5. Semantic tableaux will show the validity of an argument form.

*6. Syllogistic arguments can be shown to be valid by showing that the syllogistic language translation is a valid argument form.

*7. Translation into quantificational languages and the subsequent use of semantic tableaux can determine the validity of English-language arguments.

*8. Human nature is what we are, what we are capable of, our essence.

*9. Great Chain of Being.

From Augustine: Confessions

*10. Evil is not a substance; it is the absence of good.

11. Since God is only good, God created only good.

*12. The difficulty with Augustine's theory is the existence of evil. If God is omnipotent, how can evil exist?

13. Everything depends on and springs from God.

*14. There is no such thing as an external force; the inner feelings are all that matter.

15. If you do a thing, then you think it is good for you.

*16. Good and evil change over time, but the law of God stays the same.

17. The Manicheistic view of good and evil is that they both exist as forces in the world.

*18. Sin is anything not done solely for the glorification and praise of God.

*19. Augustine's derivation of the soul versus the body is derived from Plato.

From Freud: Character and Culture

*20. Conscience is divided into the id, superego, and ego.

*21. Freud's major innovations were (1) the abandonment of hypnosis and (2) the belief that all mental disorders are due to some sort of sexual dysfunction.

*22. The irreconcilable ego is a result of the tension arising between the libido and culture. The ego is not the master of its own house.

*23. Religion is an extension of man's egoism.

From Hobbes: Leviathan

*24. All that is distinctly human is against nature even though it is inseparable from it.

25. The mechanical philosophy sees man as affected by the laws of nature.

*26. Free will, the soul, and behavior are reduced to motion.

27. The sovereign has absolute right/power.

From Plato: Republic

*28. Control of the appetitive desires can be accomplished either through overfortifying the rational part or lowering the standards of the appetite.

*29. The dialectic conflict is to succeed in a good, rational internal way.

*30. The theory of forms contends that only real knowledge is obtainable through reason.

*31. Function determines nature.

32. What is good is both pleasant and truly beneficial to your happiness.

*33. Man can only achieve happiness in a perfect state.

34. In order to survive, one must live morally. In an ideal society, the moral person will be noticed and rewarded accordingly.

*35. Reason/rationality is the key to knowledge; it acts as the organizer of the soul.

From Sartre: Dirty Hands in No Exit and Three Other Plays

*36. Existence precedes essence.

*37. Man is condemned to be free.

*38. Human nature is not to have a nature.

*39. Action occurs because of a moment of irreducible decision.

40. Man is no more or no less than his actions.

41. Man should live so that he can look back and say, "I would do it again."

42. No matter what we do, we are ultimately responsible for doing it.

METAPHORS USED IN PHILOSOPHY: THE DIFFICULTIES NOTED

*1. Society is an artificial man. (Hobbes, Leviathan.)

*2. "The branches of these tree-like diagrams or semantic tableaux are vertical lines or vertical line segments connected by slanted lines, with a heavy dot or root at the top." (Massey, G. Rules of the Mind.)

*3. The structure of the soul is like the structure of the state. (Plato. Republic.)

SPECIALIZED LANGUAGE STYLE FACTORS IN PHILOSOPHY: THE DIFFICULTIES NOTED

Specialized language style factors involve the use of words in sequences or combinations that are unique to a particular discipline but not to every-day expression in other areas. The words would be easily understood separately, but the discipline specific arrangement may make the expression difficult for the novice to understand. In other cases the language style may be both unique to the discipline and also reflect the language style of a particular or historical period.

*1. One is able to construct valid arguments, to derive the consequences of a set of premisses or assumptions, through natural deduction. Central to natural deduction are the consistency and completeness metatheorems which state:

Consistency metatheorem--If there is a deduction of B from A_1. . . , A, then A_1 . . . , A_n imply B.

Completeness metatheorem--If A_1, . . , A_n imply B then there is a deduction of B from A_1, . . . , A_n.

*2. Fundamental Principle II: "If A_1. . . . A_n, C is an argument of a sentential language, then A_1. . . . , A_n, C is a valid argument form." (Massey, G. Rules of the Mind, p. 94)

*3. "It is not the case that. . . . "

*4. The liberty of a subject, lieth therefore only in those things, which in regulating their actions, the sovereign hath praetermitted: such as is the liberty to buy, and sell, and otherwise contract with one another; to choose their own abode, their own diet, their own trade of life, and institute their children as they themselves think fit; and the like. (Hobbes. Leviathan, p. 161)

*5. For whereas there were two orders of men, whereof one was Lords, the other Commons; the Lords had this privilege, to have for judges in all capital crimes, none but Lords; and of them, as many as would be present; which being ever acknowledged as a privilege of favour, their judges were none but such as they had themselves desired. (Hobbes. Leviathan, p. 182)

COMPLEX SENTENCE STRUCTURES IN PHILOSOPHY: THE DIFFICULTIES NOTED

*1. All these things and their like can be occasions of sin because good though they are, they are of the lowest order of good, and if we are too much tempted by them we abandon those higher and better things, your truth, your law, and you yourself, O Lord our God. (Augustine, Confessions, p. 48)

*2. Experience soon showed that the attitude which the analytical physician could most advantageously adopt was to surrender himself to his own unconscious mental activity, in a state of easy and impartial attention, to avoid so far as possible reflection and the construction of conscious expectations, not to try to fix anything that he heard particularly in his memory, and by these means to catch the drift of the patient's unconscious with his own unconscious. (Freud, S. Character and Culture)

*3. Fundamental Principle I: "If two arguments have the same number of premisses and if each premiss of the first argument is synonymous with the corresponsing premiss of the second argument, and if the two conclusions are synonymous, then the one argument is valid if and only if the other is valid." (Massey, G. Rules of the Mind, p. 93)

*4. The preservation of the belief which has been inculcated by the law through one's education as to what things and what kinds of things are to be feared, and by always I meant to preserve this belief and not to lose it when one is in pain, beset by pleasures and desires, and by fears. (Plato. Republic, p. 94)

*5. There are four such processes in the soul, corresponding to the four sections of our line: understanding for the highest, reasoning for the second; give the name of opinion to the third, and imagination to the last. (Plato. Republic, p. 166)

Chapter References

The textbooks and references from which some explanations in this chapter were drawn are:

Freud, S. *Character and culture*. New York: Macmillan, 1963.

Hobbes, T. *Leviathan*. New York: Macmillian, 1962.

Massey, G. *Rules of the mind*. Pittsburgh: University of Pittsburgh, University External Studies Program, 1979.

Plato. *Plato's republic* (G.M.A. Grube, trans.) Indianapolis: Hackett, 1974.

Saint Augustine. *Confessions*. New York: Penguin, 1980.

Sartre, J. P. *No exit and three other plays: Dirty hands, the flies, the respectful prostitute*. New York: Random House, 1976.

Chapter 8

INSTRUCTIONAL TECHNIQUES FOR PHILOSOPHY AND LOGIC

During the first 18 months of the project, the project team identified 168 receptivity difficulties in philosophy and logic, 90 of which were reported with sufficient frequency to be considered serious. Over 30 ideas for instructional techniques and devices were then outlined by the team. After a period of informal testing with student groups and close consultations with members of philosophy faculty, those initial techniques and devices were revised, refined, and combined to form the series of 20 techniques and devices presented here. Because of the considerable variations in content that exist in both introductory logic and introductory general philosophy courses, the devices and techniques presented here are designed to illustrate general principles which can be applied to a wide range of specific course contents. Therefore, even if an instructor intends to cover none of the particular topics specifically addressed by these devices, he will still find many of them easily adaptable to his own needs. Student and faculty evaluations of the devices are summarized at the end of the chapter. The list, with pages where they can be located, follows:

FOR GENERAL PHILOSOPHY COURSES

FOR INTRODUCTORY LOGIC COURSES

PHILOSOPHICAL INTUITION INVENTORY

Purpose: A pre-instructional device that leads each pupil to articulate his or her personal philosophy on major issues covered in philosophy classes.

Description: At the first class session the students are given a short answer questionnaire which requires them to describe their views on the various philosophical issues. The questions on the inventory pertain to each of the major principles or views covered throughout the term.

Learning Principle: Students call forth their prior knowledge and personal beliefs on key issues thus developing a mental scaffolding for the term's course content.

Time Required for Use: One hour (minimum)

Preparation

Materials Required: Mimeograph stencil or ditto master
Paper

Production Steps: Reproduce one inventory for each pupil enrolled in the class.

Teaching Suggestions

1. Distribute a copy to each of the students in the class and emphasize that the purpose of the inventory is to help them clarify their thoughts and to give the instructor a measure of their views and concerns about important philosophical issues.
2. After reviewing the completed inventories, the instructor returns them to the students to be placed in their notebooks. Each inventory question can be reproduced on a separate sheet and then used as a divider in the student's philosophical logbook. (See "Philosophical Logbook" technique.)
3. Students' responses to the pre-instructional inventory can be used to select members for study group triads. Group discussions and debates can be encouraged by grouping students together who have varied initial intuitions. (Study group triads are described in "Student Participation in Dialectical Reasoning".)
4. The inventory can be used as a post term device to help the student recognize and assess his philosophical development.

(Refer to Inventory on the following page.)

Inventory of Intuitions in Ethics

Directions: Answer each question in one or two short paragraphs. Try to give your own honest view, not what you think the teacher will regard as right.

1) Where do right and wrong come from? God? Society? Nature? Inner Conscience? Somewhere else?

2) Can there be a moral code that applies to all situations, in all societies and cultures, in all times? If there were intelligent creatures (say, in outer space) who had different, non-human emotions, would our moral codes apply to them?

3) What role does religion play in morality? What role should it play? If you think God determines moral rules, could He make murder and torture right?

4) Is is right to violate a moral rule (for example, break a promise or tell a lie) if it increases the amount of happiness in the world? Or should we always obey the moral code no matter what the consequences are?

5) When people disagree about morality (for example, whether abortion is murder), how do we decide who is right? How should we decide?

6) Is is generally in our self-interest to behave morally? Is it always in our interest? If not, why should we be moral?

7) Why do you think human beings have moral rules? What is the point of classifying actions into the categories of right and wrong?

PHILOSOPHICAL LOGBOOK

Purpose: A multi-purpose technique to (1) enhance student recognition of reading and listening comprehension difficulties, (2) stimulate active involvement in class discussions and (3) encourage the application of philosophical concepts and theories to topical situations.

Description: A philosophical logbook is maintained by each student throughout the entire term. On a weekly basis, the student records in the form of questions those terms, complex sentences and language styles found in the textbook or presented in lecture which are difficult to understand. For each problematic language component, the student consults a reference source (standard dictionary, philosophy dictionary, textbook, instructor, etc.) to develop and record a definition or explanation in his own words. As the student rereads the assigned material, he records and explains on page two of the log section what are perceived to be the major philosophical principles or concepts of the assignment. Next, the student peruses newspapers and periodicals to find articles that correspond to these principles. Clippings or copies of several articles, columns or letters are mounted on page three of the log, and on page four, the student relates them and evaluates them according to the different philosophical positions presented in the readings and lectures.

Learning Principle: Meaningful learning is enhanced by increasing the number of associations the student can make between what is being taught and what he or she already knows.

Time Required for Use: Ongoing throughout the duration of the school term.

Preparation

Materials Required: Instruction Sheet (mimeograph or ditto)
Each student provides his own loose-leaf or spiral-bound notebook.

Production Steps: Reproduce sheet of instructions. Request students to procure necessary materials.

Teaching Suggestions

1. The instructor should collect and comment on the logbooks on a regular basis. This appears to be particularly important during the early phases of the term.

2. The logbooks can be the basis for discussions in smaller classes or recitation sections.
3. In some classes (e.g. advanced metaphysics, higher logic, etc.) the technique can be adapted or shortened to meet the needs of the students and nature of the course.

(See instruction sheet on the following page.)

(Sample)

Instruction Sheet for Philosophical Logbook

Throughout the term, you will be responsible for keeping a Philosophical Logbook, for which you will need a soft-cover, loose-leaf or spiral notebook. As you do each assigned reading, you are required to complete a four-section unit in your logbook. (You should devote one page to each section).

Section 1: Difficulties in the Reading.

In the first section of each unit, you will record words and passages from the reading which you have difficulty understanding. Beginning students in philosophy often find the reading assignments quite difficult at first. Compared to other kinds of writing, philosophical prose contains very little factual, descriptive, or historical material; instead, it mostly consists of abstract reasoning of a subtle and sophisticated sort. In addition, it often contains unfamiliar terminology and forms of expression. Hence, if you want to understand this material, you must read it more than once!

The first time you read a selection, you should put a small check mark in the margin each time you encounter a term or passage you don't understand. The second time you read the passage, some of these difficulties should be cleared up, but some words and passages will still be unclear. Record each remaining unclear word or passage on the first page of your log for this unit, and leave some space after each entry. Now you should use a dictionary to clarify each difficulty in your list. You may want to consult other reference works (like philosophy textbooks or specialized philosophical dictionaries) as well. You should write a brief explanation following each difficulty you succeed in clearing up. Ask your lecturer or recitation leader about any remaining difficulties, and then enter the explanations for these entries in your logbook.. (Start this section on a left hand page, so you can see Section 2 without turning the page).

Section 2: Key passages

By the second or third time you read a selection, you will have a pretty good idea of what it says. Look for the key passages in which the author sums up his most significant ideas. Choose the three or four most important of these key passages and record them on page two of the logbook unit, leaving some space after each. Then, in your own words, paraphrase each key passage as clearly as you can in the space you have provided. (This section should be entered on a right-hand page, facing section 1).

Section 3: Relevant Clippings.

The great philosophical questions ("What is justice?" "What is human nature?", etc.) are perennial. Start looking for items touching on these issues in the newspapers (the editorial and advice sections usually have many good examples) and news magazines (like Time & Newsweek). Clip the best of these items and tape (or staple) them to page three of the unit. (This section of the unit should be on a left-hand page).

Section 4: Comment on Clippings.

On the right-hand page facing section 3, write a brief commentary on each clipping, explaining how it touches on the philosophical ideas covered in the unit, and describing how the different philosophers studied in the course would react to the item.

STUDENT PARTICIPATION IN DIALECTICAL REASONING

Purpose: To encourage student generation of a definition or explanation through a process of Socratic dialectic.

Description: The students meet in triads, and the instructor assigns each triad three terms, concepts, or a rule from the unit of study. Then, one student explains the term, concept, or rule and the other student determines if the explanation is complete. If not, he asks leading questions or makes verifying comments. A third student records the interchange in a log which can be reviewed by the instructor for diagnostic purposes.

Learning Principle: Verbalization facilitates learning.

Time Required for Use: Variable

Preparation

Materials Required: List of terms, concepts, or rules on chalkboard

Production Steps: 1. Organize the students into triads
2. Assign each triad three terms, concepts, or rules from the unit of study.

Teaching Suggestion

1. During the initial weeks of the school term, the students are taught the criteria for a logically proper definition of a term, concept or rule. After this presentation by the instructor, the students should be given a handout or reference source on developing definitions which maybe consulted throughout the semester.

2. Next, each of the students in the class should be placed into triads which will function throughout the duration of the semester. It is recommended that the formation of the triads be based upon the students' achievement levels (scores on the first class quiz). After rank ordering the criterion scores, the triads are formed by randomly selecting a student from the top third of the distribution, one from the middle third and another from the lower third to form a triad. This process is repeated until all of the class members are placed in triads. If necessary, the groups should be formed with four students rather than two students to allow the process to function if a student is absent from class. Other methods of forming triads such as randomization or student selection may be used at the discretion of the instructor.

3. Class Session #1

Each class member should be given a list of three related terms, concepts, or rules and a list of reference sources where definitions or explanations can be located. As the term progresses the references sources should be ones that provide subtle differences in the ways professionals within the discipline view the subject. As a homework assignment, the students are instructed to develop well-formed definitions for each of the terms as well as several probing questions pertaining to each one.

4. Class Session #2 or Recitation Session

The students break up into their assigned triads and each student will assume a duty with the triad. The leader/explainer provides a tentative definition of the first term. The questioner asks probing questions about the definition or raises objections to the definition which are answered or clarified by the leader. The logkeeper/researcher keeps a record of all of the tentative definitions, questions and objections. This individual may also provide verifying comments whenever called upon. The group's interaction continues until a stage of acceptance is reached at which time a final definition is noted in the log and in the students' personal notebooks or vocabulary guides.

5. Class Session #3

The recorders are asked to share the groups' conclusions during a class discussion facilitated by the instructor. The instructor attempts to clarify misunderstood points raised in class or noted in the sample of logs. The students are encouraged to raise questions as necessary for understanding the material.

6. A final optional step would be to convene the triads so that each group can develop a statement on how the different terms, concepts, or rules are related to one another.

(Refer to the instruction sheets on the following two pages.)

Instruction Sheet for Triads

Rules for Definition

A logically proper definition of a term must

(a) state the essential properties of the thing named by the term (that is, it must specify those features a thing must have if it is properly named by the term).
(b) be neither too narrow nor too broad (that is, it must describe or fit all things named by the term and nothing else).
(c) not be circular (that is, the term to be defined must not be part of its own definition).
(d) not contain vague, metaphorical or ambiguous language.

Instructions to the Explainer:

Your job is to get things going and keep them moving by proposing tentative definitions and revising them in light of the comments by your questioner and recorder. The best way to start is by specifying the general category covering the term (An automobile is a land vehicle...) and then adding properties to narrow it down (...with four wheels and an internal combustion engine.) Be ready to offer ammendments when your questioner finds shortcomings ("Wouldn't that cover trucks and farm tractors too?"). When you have offered a definition, wait until your questioner and recorder have both commented before offering your revision. If one approach doesn't seem to work try another. The more ideas you can present to your triad, the better.

Instructions to the Questioner:

Your job is to test each definition according to all the four rules. The hardest rule to satisfy is rule (B). In order to insure that your triad's definition of a term satisfies rule (B), you must try to find counter-examples to each formulation your explainer presents. If you can think of something that is included by a definition given by your explainer but shouldn't be, that is a counter-example showing the definition to be too broad. If you can think of something that isn't included by the definition but should be, that is a counter-example showing the definition to be too narrow. Use your imagination!

Example: An automobile = if a self-propelled, wheeled vehicle designed for transportation on land.

Counter-example #1: A bus is included by this definition but shouldn't be, since it is not an automobile. The definition given is too broad.

Counter-example #2: An Indy 500 race car is not included by the definition, since it is not designed for transportation, but it should be included, since it is an automobile. So the definition given is also too narrow.

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Instructions to the Recorder:

You have three jobs in this exercise. First, you should write down each definition your explainer presents and the objections your questioner makes to each. Second, you should function as a facilitator for your group, helping both your explainer and your questioner, mediating disagreements, and seeking a consensus. Finally, when a consensus is reached, you are responsible for presenting your traid's result to the class and defending it.

Remember to rotate roles after each definition.

PICTORIAL REPRESENTATION OF METAPHYSICAL THEORIES

Purpose: To increase the students' comprehension of the different ways philosophers have viewed the world by supplementing verbal explanations with pictorial analogues.

Description: The instructor presents the class with pictorial representation of the world as conceived by different philosophers.

Learning Principle: Supplementing verbal explanation with pictures, aids, comprehension and recall.

Time Required for Use: Variable

Preparation

Materials Required: Blackboard and chalk
Handout (standard methods of reproduction)
Transparencies for overhead projector

Production Steps:

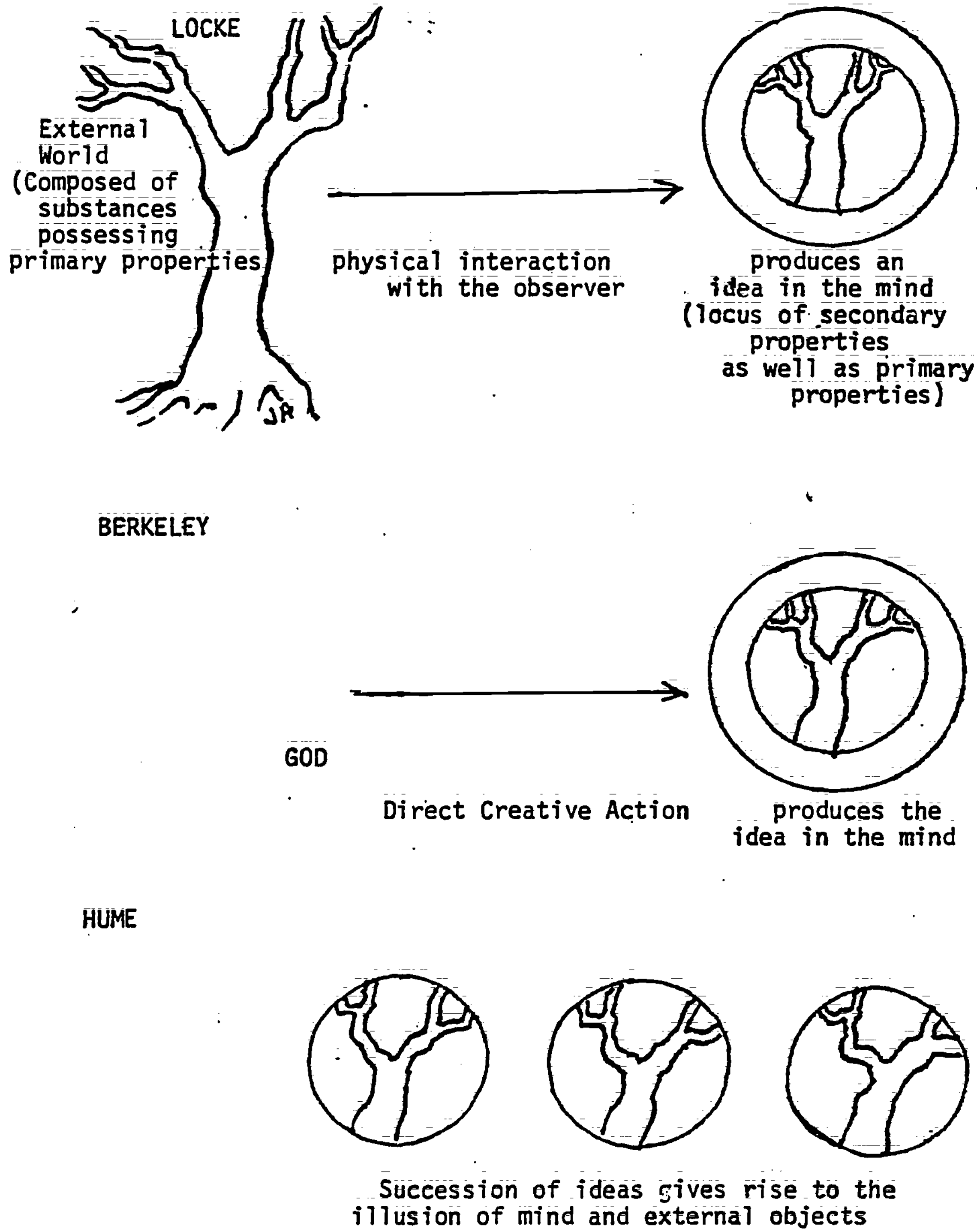
Teaching Suggestions

If the pictures are presented on the blackboard during the lecture, it is advisable also to provide the students with a handout.

The philosophical literature contains a number of such pictorial representations, especially in works by Roderick Chisholm, Richard Taylor, and Wilfred Sellars.

(See illustration on the following page.)

Effects of Ockham's Razor on British Empiricism



DEMONSTRATION TO

CONTRAST DIFFERENT TYPES OF REASONING

Purpose: To illustrate the nature of deductive reasoning by contrasting it with inductive and hypothetical reasoning.

Description: Using an opaque container filled with uniformly colored beans, the instructor leads the students through an inductive inference, a deductive inference, and a hypothetical inference. (See Protocol)

Learning Principle: A concept gains clarity through contrast.

Time Required for Use: 10 minutes (approximately)

Preparation

Materials Required: Opaque container (paper bag, cloth sack, coffee can, etc.)
Uniformly colored beans
Blackboard and chalk

Production Steps: Place beans in container.

Teaching Suggestions

It is important that the instructor lead the students to draw the required inference in each case. After each inference, the instructor should write the argument on the blackboard so that the students can see all three different types of reasoning juxtaposed.

(Refer to demonstration on the following page.)

Demonstration for Contrasting Different Types of Reasoning

Start with the question, "What is in the bag?" After shaking the bag, you should withdraw a handful of beans and lead your students through the inductive inference:

(Case) The beans are from this bag.
(Result) These beans are white.
Therefore, (Rule) All the beans from this bag are white.

You should then remove another handful of beans from the bag, but, this time, you should keep them concealed, so that the students do not see what color they are. Then, asking the class "What color are these beans?" you should lead your students through this deductive argument:

(Rule) All the beans from this bag are white.
(Case) These beans are from this bag.
(Result) These beans are white.

(Note: You may want to point out to your class how science frequently uses the conclusion of an inductive argument as the major premiss of a deductive argument.)

Finally, you should remove a bean from your pocket and ask, "Where did this bean come from?" and lead your students through a hypothetical argument:

(Rule) All the beans from this bag are white.
(Result) This bean is white.
Therefore, (Case) This bean is from this bag.

(You might want to point out the dangers of hypothetical reasoning by showing your class that even though the premisses of this argument are true, that the conclusion can be false.)

VERBAL/VISUAL BINARY PRESENTATION

<u>Purpose</u>: To improve the students' comprehension of potentially troublesome terms and concepts.

<u>Description</u>: When a key notion can be presented both discursively and pictorially (through a schematism or a diagram), both media are employed simultaneously, and the corresponding elements are connected through color-coding or arrows.

<u>Learning Principle</u>: Two modes of presentation can clarify and reinforce each other.

<u>Time Required for Use</u>: Variable

Preparation

<u>Materials Required</u>: A. Chalkboard & colored chalk
or B. Overhead projector, transparency, colored felt marker
or C. Posterboard & colored felt-tip marker (small groups only)
or D. Mimeo handout

<u>Production Steps</u>: The instructor writes the verbal description on the left, underlining the key terms, then draws the pictorial representation on the right, and finally relates the underlined terms to their corresponding pictorial elements by color-coding, drawing arrows, or by pointing.

Teaching Suggestions

Applicable to a wide number of subject areas and class sizes, this technique is especially useful for courses (like Intro. to Logic) which require mastery of a great number of unfamiliar technical terms and concepts. In Intro. to Logic, for example, it is applicable to many definitions and practically all rules. It can be used in detail, on the blackboard or overhead projector as the focus of a lecture, or it can be used merely as a supplementary handout, depending on the importance of the topic and time available.

VERBAL/VISUAL BINARY PRESENTATION

1 The major term of a syllogism is the term which appears as the grammatical predicate of the conclusion.

All S is M
All M is $\boxed{P}$
∴ All S is $\boxed{P}$

2 The minor term of a syllogism is the term which appears as the grammatical subject of the conclusion.

All S is M
All M is P
∴ All S is P

3 The middle term of a syllogism is the term which does not appear in the conclusion.

All S is M
All M is P
∴ All S is P

DEFINITION EXERCISE FOR DISAMBIGUATION

Purpose: To minimize difficulties arising from ambiguous or very similar terms.

Description: The student is provided a study sheet on which he gives parallel definitions of the term's different meanings in close juxtaposition.

Learning Principle: The generation of explicit definitions helps to prevent the confusion of distinct concepts.

Time Required for Use: under 5 minutes

Preparation

Materials Required: Standard methods of duplication (ditto, mimeo, etc)

Production Steps: Prepare a handout with introductory explanation and appropriately labelled boxes in which the definitions are to be entered.

Teaching Suggestions

1. This device may be given out before or after presenting the relevant subject matter. When used before, it can form the basis of a lesson in which the instructor uses the student's responses Socratically to provoke critical discussion leading to a acceptable set of definitions.
2. If two or more of the concepts are logically (or otherwise systematically) related, then questions about these relationships may be helpfully included on the handout, providing that this supplementary material does not add daunting complexity. Visual and conceptual simplicity are the key.

(Refer to worksheet on the following page.)

You have been introduced to three different concepts which share the name 'validity.' It is important not to confuse them. It will help you to keep them straight if you write their definitions in the appropriate box, and keep this sheet with your notes for review.

1. Validity of a wff:

2. Validity of an argument form:

3. Validity of an argument:

What does Fundamental Principle II say about the relationship between 2 and 3? (You'll remember this principle better if you can put it in your own words)

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FORMULA BUILDING AND VERIFYING

<u>Purpose</u>: To foster the student's understanding that other well-formed formulas can be created from an existing well-formed formula.

<u>Description</u>: This device consists of a transparency and series of overlays. The transparency contains the letter A representing a simple sentence (a WFF). Subsequent overlays contain a $\sim$, a $(\cdot B)$, a $(\vee B)$, a $(\equiv B)$, and a $(\supset B)$. Each overlay is individually placed over the transparency to create a well-formed formula.

<u>Learning Principle</u>: Learning is facilitated if new material is based on previous knowledge.

<u>Time Required for Use</u>: 5-10 minutes

Preparation

<u>Materials Required</u>: Transparency and overlays

<u>Preduction Steps</u>:
1. Indicate sentence letter A on a transparency.
2. Construct overlays which indicate $\sim$, $(\cdot B)$, $(\vee B)$, $(\equiv B)$, and $(\supset B)$.

Teaching Suggestions

1. In lecture, this technique may be used for initial explanation of the term, "well-formed formula."

(See formula on the following page.)

Building a Well-Formed-Formula (Wff)

	Wff	Rule
(1st transparency)	A	1. Any sentence variable standing alone is a wff.
(2nd transparency)	$\sim A$	2. If A is a wff, then $\sim A$ is a wff.
(3rd transparency)	$(\sim A \vee B)$	3. If A and B are wffs, then $\ulcorner(A\cdot B)\urcorner$, $\ulcorner(A\vee B)\urcorner$, $\ulcorner(A\supset B)\urcorner$ and $(A\equiv B)$ are wffs.
(4th transparency)		4. Nothing else is a wff.

OVERLAY TRANSPARENCIES AND WORKSHEETS FOR INTERLINEAR TRANSLATION EXERCISE

Purpose: To enable students to recognize the logical structure of arguments in natural language and to make that structure explicit.

Description: A series of five transparencies is overlaid in sequence to introduce a method of interlinear annotation of arguments which culminates in a translation of the argument into the propositional calculus.

Learning Principle: Overhead projection of transparencies hold attention and emphasize the sequential nature of the procedure. The interlinear method illustrates how the abstract calculus applies to reasoning in natural language.

Time Required for Use: 10-15 minutes

Preparation

Materials Required: 1. For Overhead Presentation: Five transparencies (one Thermofax), colored overhead markers.
2. For Worksheets: Mimeo master, paper.

Production Steps: 1. Type an argument in English at the top of a sheet of paper, using triple or quadruple spacing. Below it, provide space for a lexicon and list as many propositional variables as the argument requires. In addition, provide a space for the final translation. Thermofax this sheet onto a transparency.
2. Using colored overhead markers, illustrate each successive step on a transparency overlay.
3. Prepare worksheets using additional arguments and the format used in Step 1.

Teaching Suggestions

1. Project initial transparency.
2. On the first overlay, find the conclusion and annotate it with three dots over its initial word.
3. On the second overlay, circle the logical connectives in the English argument and annotate them by writing the appropriate logical symbol above each.

4. On the third overlay, underline each proposition, annotate it with a variable, and enter it in the lexicon. Use a different color marker for each different proposition.
5. On the final overlay, write the translation in the space provided, preserving the color-coding of the propositional variables.
6. Hand out worksheets so that the students can try the procedure themselves.

(See demonstration on the next two pages.)

An Economic Dilemma

Minimum wage laws can set wages above the market level or they can set wages at or below the market level. If they set wages at or below the market level, they are useless. If they set wages above the market level, they produce unemployment. Hence, minimum wage laws either create unemployment or they are useless.

Lexicon

p -
q -
r -
s -
p_1 -

Translation

p

Minimum wage laws can set wages above the market level or

q $\supset$

they can set wages at or below the market level. If they set

q r $\supset$

wages at or below the market level, they are useless. If they

s

set wages above the market level, they produce unemployment.

$\therefore$ s $\vee$

Hence, minimum wage laws either create unemployment or they

r

are useless.

Lexicon

p - *minimum wage laws set wages above market level.*

q - *minimum wage laws set wages at or below market*

r - *they are useless*

s - *they create unemployment*

p_1 -

Translation

$$\begin{array}{l} p \vee q \\ q \supset r \\ p \supset s \\ \hline \therefore s \vee r \end{array}$$

final result using all five transparencies

PICTORIAL SEMANTICS FOR

CATEGORICAL SENTENCE FORMS

Purpose: A device to assist the students in understanding the difference between the Aristotlian interpretation and the modern interpretation of the four categorical sentence forms.

Description: An overhead transparency with multiple overlays showing pictorial representations of situations that satisfy the truth-conditions of the four categorical sentence forms is presented to the class. As the first overlay (A) is shown, the Aristotlian interpretation is explained. Next the modern, null-case alternate interpretations of A (universal affirmative) and E (universal negative) are demonstrated as overlay B is substituted for overlay A.

Learning Principle: Visualization facilitates learning.

Time Required for Use: 10-15 minutes.

Preparation

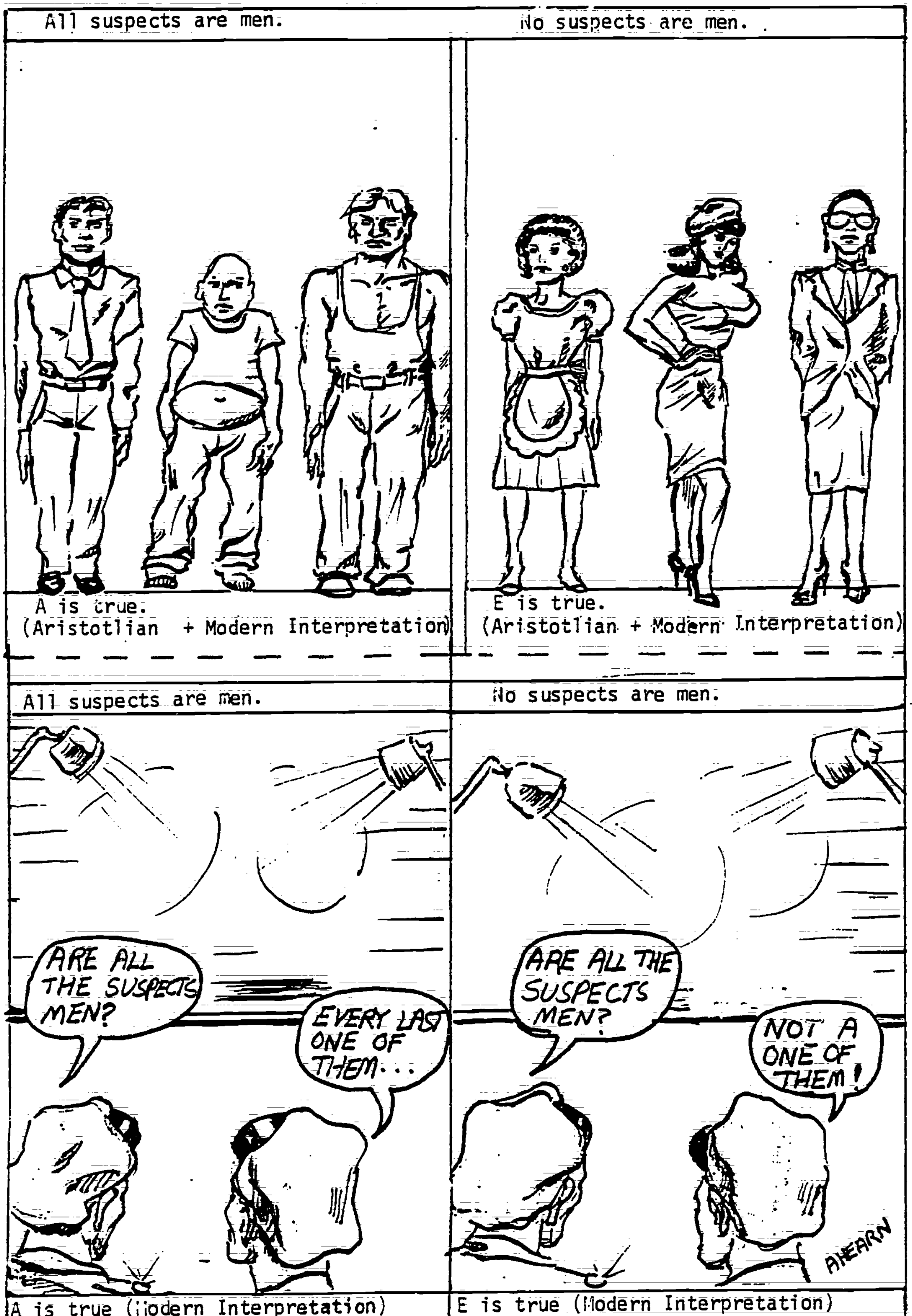
Materials Required: Two thermofax transparencies
Scissors
Tape
Overhead projector

Production Steps: Develop a transparency of each of the illustrations on the following two pages. Transparency II should be cut along the broken vertical line across its center. The resulting halves will serve as overlays to be used with transparency I. To create a single instructional device, hinge overlay A with tape to the upper left side of transparency I and then hinge overlay B to the upper right side of the transparency.

Teaching Suggestions

1. To overcome a possible receptive communications problem be sure to explain that according to the modern interpretation, A and E are true if <u>either</u> the Aristotlian state of affairs <u>or</u> the null-case state of affairs is appropriate.
2. This device can be used to introduce a presentation of the differences between the modern and the Aristotlian Squares of Opposition.

(Refer to illustrations on the following two pages.)


All suspects are men.
A is true.
(Aristotlian + Modern Interpretation)
No suspects are men.
E is true.
(Aristotlian + Modern Interpretation)
All suspects are men.
ARE ALL THE SUSPECTS MEN?
EVERY LAST ONE OF THEM...
A is true (Modern Interpretation)
No suspects are men.
ARE ALL THE SUSPECTS MEN?
NOT A ONE OF THEM!
AHEARN
E is true (Modern Interpretation)

When are the categorical sentence forms true?

Some suspects are men.

I is true.
(Aristotlian + Modern Interpretation)

Some suspects are not men.

O is true.
(Aristotlian + Modern Interpretation)

SMALL GROUP PROCESS FOR CATEGORIZATION

Purpose: To enhance student learning of the translations for the truth-functional connectives.

Description: This device consists of a list of possible connectives (and columns labeled with the symbolic translation for the truth-functional connectives). Working in groups of three or four, the students categorize the words under the proper symbolic translation.

Learning Principle: Peer instruction facilitates the learning process.

Time Required for Use: 5 minutes

Preparation

Materials Required: Handout with list of connectives and columns headed by truth-functional connective symbols.

Production Steps: 1. Type connectives and symbols for connectives on paper.
2. Duplicate.

Teaching Suggestions

Early in the study of truth-functional connectives, the students may use this device in small group sessions. The students may also wish to use this exercise as a review.

(Refer to demonstration sheet on the following page.)

Place each English connective in the column labeled with its correct symbolic translation.

if and only if
it is not the case that
unless
not
provided S_1, then S_2
in case and only in case
although
it is false that
if S_1, then S_2
and

either....or
S_1 only if S_2
in case S_1, then S_2
however
since
un-, in-, non-
but
provided and only provided
in the event and only in the event

$\sim$	$\bullet$	$\vee$	$\supset$	$\equiv$

TRANSLATION OF NON-TRUTH-FUNCTIONAL OPERATORS

Purpose: To clarify and reinforce the concept of truth-functionality.

Description: The students are given, on a handout or on the blackboard, a set of non-truth-functional English connectives and are required to give a logically clear definition of their meaning.

Learning Principle: Concepts are clarified and reinforced through contrast.

Time Required for Use: 15 minutes or more

Preparation

Materials Required: Handout (standard forms of duplication) or
Blackboard and chalk or
Transparency and overhead projector

Production Steps: Compile a list of non-truth-functional English connectives and present it to the students with appropriate instructions.

Teaching Suggestions

This exercise should begin with terms (like "before" and "because") that have a clear truth-functional component (like conjunction). This exercise is especially good for use with a study group format.

(Refer to handout on the following page.)

Lexicon of Non-truth-functional Connectives

Directions: for each English connective, provide a definition that reveals as much of its logical content as possible.

EXAMPLE p before q	p is true and q is true and q occurred later in time than p
p after q	
p whenever q	
necessarily p	
It's a shame that p	
P because q	
P, therefore q	

INVALIDITY RECOGNITION THROUGH COUNTER-EXAMPLE

Purpose: To clarify the distinction between the concept of validity and the concept of truth.

Description: The student is presented with an invalid argument with true premisses and true conclusion, and is required to construct another argument of the same form with true premisses and a false conclusion.

Learning Principle:

Instructional Time Required: Variable

Preparation

Materials Required: Handout

Production Steps: The instructor writes out several invalid arguments with true premisses and conclusion, and provides appropriate spaces for the student to specify the logical form and to construct an analogous argument with true premisses and a false conclusion.

Teaching Suggestions

1. This device is a good introduction to a study of common fallacies.
2. This device works well as a classroom exercise for small study groups in which the students can assist each other.

(See handout on the following page.)

Counter-exampling Invalid arguments

Directions: For each argument, determine its logical form and construct another argument of the same form, giving it true premisses and a false conclusion.

EXAMPLE:

If it rains, the street will get wet.
But it hasn't rained.
So the street is not wet.

This argument has the logical form: $\begin{array}{l} p \supset q \\ \underline{\sim p} \\ \sim q \end{array}$

So does this argument: If Lech Walesa were Pope, the Pope would be Polish.
But Lech Walesa isn't Pope.
So the Pope isn't Polish.

Since the second argument has true premisses and a false conclusion, it must be invalid. Furthermore, since the first argument has the same logical form as the second, it must also be invalid. The second argument, then, is a <u>counter-example</u> to the first. Construct counter-examples for the following arguments.

1. If it rains, the street will get wet.
   The street is wet.
   So it must have rained.

2. Copernicus's theory contradicts Ptolemey's.
   But Ptolemey's theory is clearly false.
   So Copernicus's theory must be true.

3. Every analytic statement is a priori.
   Only a priori statements are analytic.
   Therefore, all a priori statements are analytic.

4. Anyone who uses language uses abstract ideas.
   But animals do not use language.
   Hence, animals do not use abstract ideas.

SUPPRESSED PREMISS EXERCISE

Purpose: A technique to illustrate the concept of enthymemes and provide students with practice in working with them.

Description: The instructor lists several arguments with one or more premisses omitted on an overhead transparency or a set of worksheets. The students are required to fill in whatever premiss is required to make each enthymeme a valid argument.

Learning Principle: Practical application of general principles promotes comprehension.

Time Required for Use: 10-45 minutes

Preparation

Materials Required: Overhead transparency or
Blackboard & chalk or
Handouts

Production Steps: The instructor writes out several arguments, leaving blanks for one or more premisses.

Teaching Suggestions

1. This technique works well in conjunction with assignments in identifying and formalizing natural language arguments in their natural contexts.
2. It seems best to start with rather simple examples and work gradually towards more complex ones.
3. This technique provides a good lead-in to a presentation on natural deduction.
4. This technique can be used with classes of any size and also recitation sections.

(Refer to example on the following page.)

Enthymeme Worksheet

Fill in whatever premiss is needed to make each enthymeme a valid argument.

1. There are bacteria on Mars.

   ?

   .·.There is water on Mars.

2. Some parents are fathers.

   ?

   .·.Some parents are men.

3. The pyramids were not built by primitive backward people.

   ?

   .·.The pyramids were not built by the ancient Egyptians.

4. Tom believes in ancient astronauts.

   ?

   .·.Tom thinks that people who lived long ago were more stupid than people living today.

5. Only bright students can find the missing premiss.

   ?

   .·.Boy, am I a bright student!

TRANSPARENCY SEQUENCE

EXPLAINING APPLICATION OF RULES

Purpose: To show the requirements for a syllogism.

Description: This device consists of a transparency with a sequence of rules. The first requirement for a syllogism is located at the top of the transparency. In a progressive manner, the four subsequent sections present the four additional requirements.

Learning Principle: Material learned in several spaced trials is retained better than material learned en masse.

Time Required for Use: 10-15 minutes

Preparation

Material Required: Transparency

Production Steps: 1. Write the first rule at the top of a transparency.

2. Place each subsequent rule so each additional requirement falls beneath the preceding requirement.

Teaching Suggestions

This technique presents information in a sequence to avoid the confusion which may result from unmasking all of the requirements at one time. During the lecture, the instructor may expose the components step by step as each is discussed. An piece of cardboard can be used to mask sections of the transparency not being discussed at the moment. An alternative mode of presentation might be to cut the transparency (from right to left) to permit one rule after another to be flipped down on to the overhead projector.

(Refer to example on the next page.)

DEMONSTRATION OF MULTIPLE REQUIREMENTS

(1) A valid standard-form categorical syllogism must contain exactly three terms each of which is used in the same sense throughout the argument.	1 2 All H are G No G are F 3 No F are H
(2) In a valid standard-form categorical syllogism, the middle term must be distributed in at least one premiss.	distributed All H are G No G are F No F are H
(3) In a valid standard-form categorical syllogism, if either term is distributed in the conclusion, then it must be distributed in the premiss.	distributed All H are G No G are F No F are H distributed
(4) No standard-form categorical syllogism is valid which has 2 negative premisses	not negative All H are G No G are F negative No F are H
(5) If either premiss of valid standard-form categorical syllogism is negative, the conclusion must be negative.	All H are G No G are F negative → No F are H

STUDENT GENERATION OF TABLEAUX RULES FOR NON-STANDARD CONNECTIVES

Purpose: To help the student in seeing how tableaux rules are derived from the semantic functions given in basic truth-tables.

Description: The instructor gives the students truth tables for one or more non-standard sentence connectives and asks them to derive the appropriate tableaux rules for these connectives.

Learning Principle: In generating the rules for non-standard connectives, the students recapitulate the reasoning logicians use to relate syntax and semantics.

Instructional Time Required: Variable

Preparation

Materials Required: Blackboard and chalk or
Handouts or
Transparency for overheads

Production Steps: The instructor writes one or more truth-tables for non-standard connectives and appropriate instructions.

Teaching Suggestions

1. This technique is applicable only after the students have seen rules for the standard connectives derived from their truth tables.
2. This technique can be modified for use with truth trees and natural deduction.
3. This technique is very effective when used as a classroom exercise in which the students are divided into small groups, each of which is assigned a different connective. One member of each group should be called on to explain the reasoning which led to the answer.

(See Tableaux Rules on the following page.)

Tableaux Rules for Non-Standard Connectives

Since there are as many different logical connectives as there are different truth tables, we could always introduce new connectives until we ran out of truth tables. Suppose we introduced the connective 'X' into our language with the truth table below. What would the tableaux rules, X-left and X-right have to be?

p	q	pXq
T	T	F
T	F	T
F	T	F
F	F	F

X-left		X-right	
pXq			pXq

What English language expression could we use 'X' to translate?

Here is another non-standard connective. What would the tableaux rules for it have to be?

p	q	pNq
T	T	F
T	F	F
F	T	F
F	F	T

N-left		N-right	
pNq			pNq

What English expression could we use 'N' to translate?

STRUCTURED OVERVIEW DESIGNED FOR GENERATING STUDENT EXPLANATIONS

Purpose: To develop understanding of the interrelationships among rules and strategies of natural deduction/derivation or semantic tableaux.

Description: In a handout sheet, the components of a unit of study are identified and hierarchically charted. In the space following the term or rule, the student supplies his explanation.

Learning Principle: The combination of diagrammatic representation and self generation of explanations will facilitate learning.

Time Required for Use: 15 minutes for distribution and explanation

Preparation

Materials Required: Paper, pen, reducing copier (if needed)

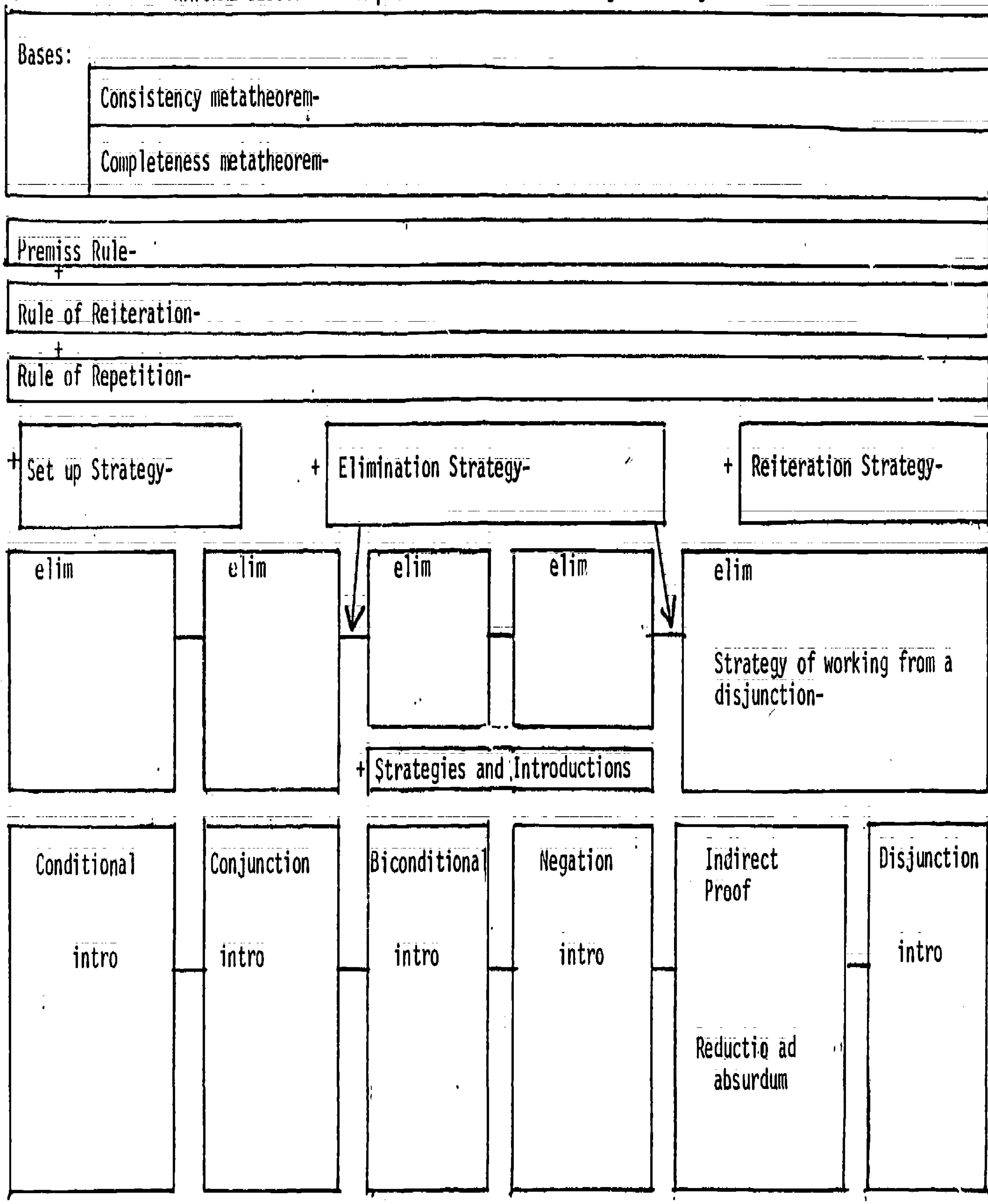
Production Steps: 1. Organize and reproduce unit material.
2. Type, copy.

Teaching Suggestions

Distribute the structured overview to the students before class. The students supply their own words as the material is presented in the lecture or as they review their notes or the reading assignment. This device may also be used in small groups with students working together to supply the definitions or explanations.

(See structure review on following page).

NATURAL DEDUCTION - A procedure for constructing valid arguments



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REVERSE REASONING PROCESS

FOR RULE COMPREHENSION

Purpose: To assist students in learning the rules of natural deduction/derivation or semantic tableaux.

Description: Students are provided with handouts which supply the conclusion of the application of a rule, and they are required to complete the steps leading to that conclusion.

Learning Principle: Student application of a rule will facilitate learning.

Time Required for Use: 5-7 minutes

Preparation

Materials Required: Paper and pencil

Production Steps: Create handout which depicts result of the rule.

Teaching Suggestions

This device may be used at the completion of the unit so the student may determine if he has learned the rule in question.

(See example on the following page.)

Example: Rules used in natural deduction/derivation

Write the appropriate steps needed to reach each conclusion.

$A \vee B$	$A \equiv B$	$\sim A$	$A \& B$	$A \supset B$

Symbolically represent the use of the elimination rules to reach the following:

$\equiv$ elim	$\sim$ elim	& elim	$\supset$ elim	$\vee$ elim
B (or A)	A	A (or B)	B	C

FLOW-CHART TO ILLUSTRATE

SYSTEMATIC REASONING

Purpose: To enhance student appreciation of and competence in reasoning in a systematic fashion.

Description: Using a simple example, the instructor shows the kind of reasoning needed to construct a natural deduction, and then illustrates it in a flow-chart.

Learning Principle: Step-by-step and cyclical processes are more easily grasped when presented in a flow-chart format than when just described verbally.

Time Required for Use: 20-30 minutes

Preparation

Materials Required:
1. Chalkboard & chalk or overhead projector
2. Mimeo or other standard forms of reproduction

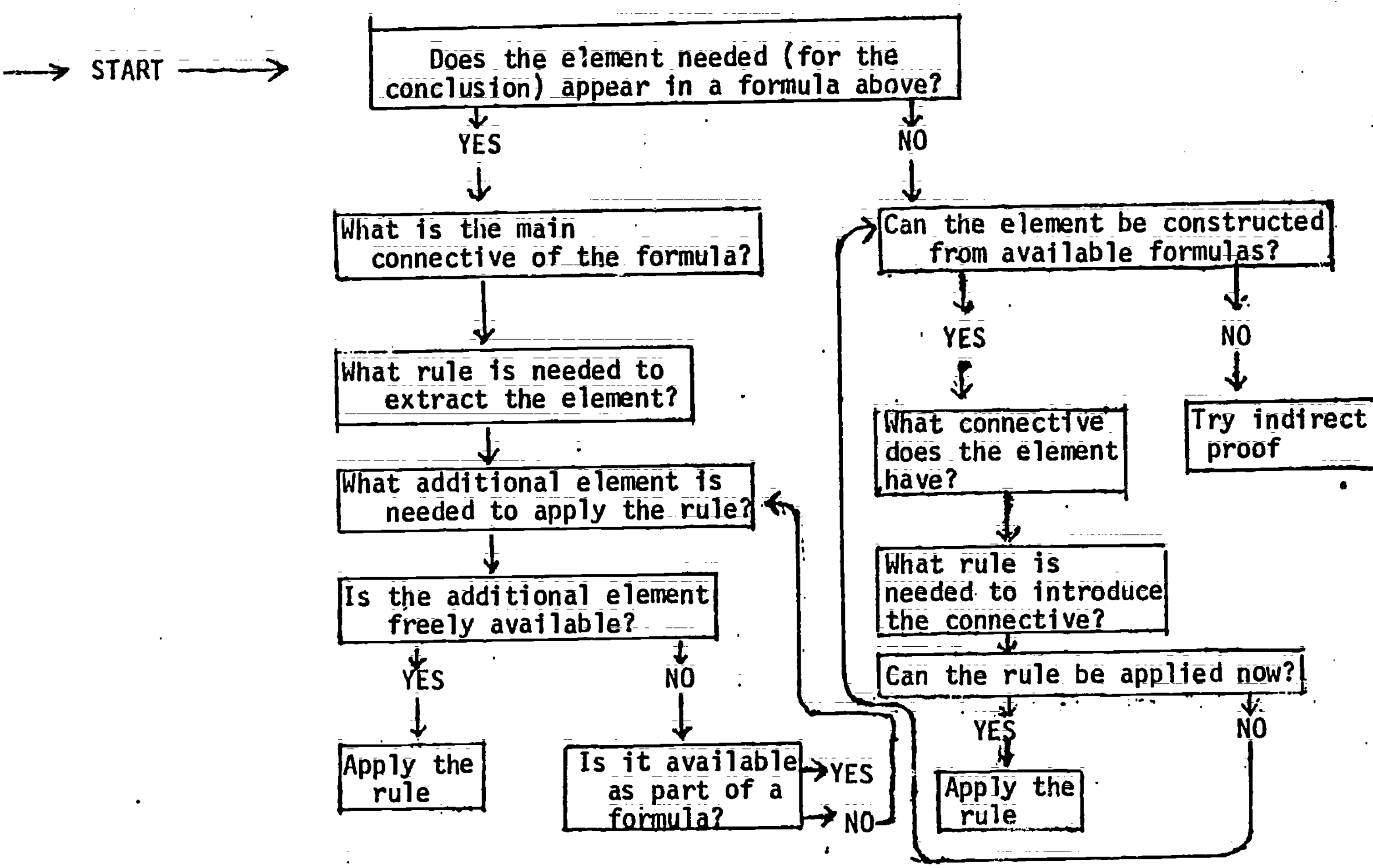
Production Steps:
1. Draw up flow-chart.
2. Reproduce flow-chart handouts.

Teaching Suggestions

1. This technique is adaptable to any systematic, step-by-step process.
2. When the students have become familiar with the flow-chart technique, they may be given assignments in which they must construct flow-charts for simple processes with which they are already familiar (e.g., constructing a semantic tableaux, etc.). Such exercises enhance analytic abilities.

(Refer to flow-chart on the following page.)

Flow-chart Of Reasoning Used To Construct A Natural Deduction



MULTI-COLORED TRANSPARENCIES
TO ILLUSTRATE A VENN DIAGRAM

Purpose: To demonstrate the symbolic equivalence of the Venn Diagram markings to the categorical sentences of a syllogism and to use the Venn Diagram to determine the validity of a syllogism.

Description: This device, consisting of a transparency and three overlays, can be used to demonstrate the translation of the categorical sentence forms of the syllogism to the Venn Diagram. The transparency contains a Venn Diagram and the syllogism, itself. Overlay Number One supplies the shading of the Venn Diagram required to depict the first premiss sentence. Overlay Number Two supplies the shading of the Venn Diagram required to depict the second premiss statement. The third overlay contains a Venn Diagram for the concluding sentence. The student should determine the validity of the argument by noting if the shaded areas of the premiss and conclusion Venn Diagram are identical.

Learning Principle: Visualization facilitates learning.

Time Required for Use: 5-10 minutes

Preparation

Materials Required: Transparency and three overlays
Overhead projector markers

Production Steps:
1. Copy the syllogism and a Venn Diagram on the transparency.
2. On the first overlay, shade the proper areas of the Venn Diagram.
3. On the second overlay, shade the proper areas of the Venn Diagram to reflect the second premiss.
4. On the third overlay, depict the conclusion sentence.

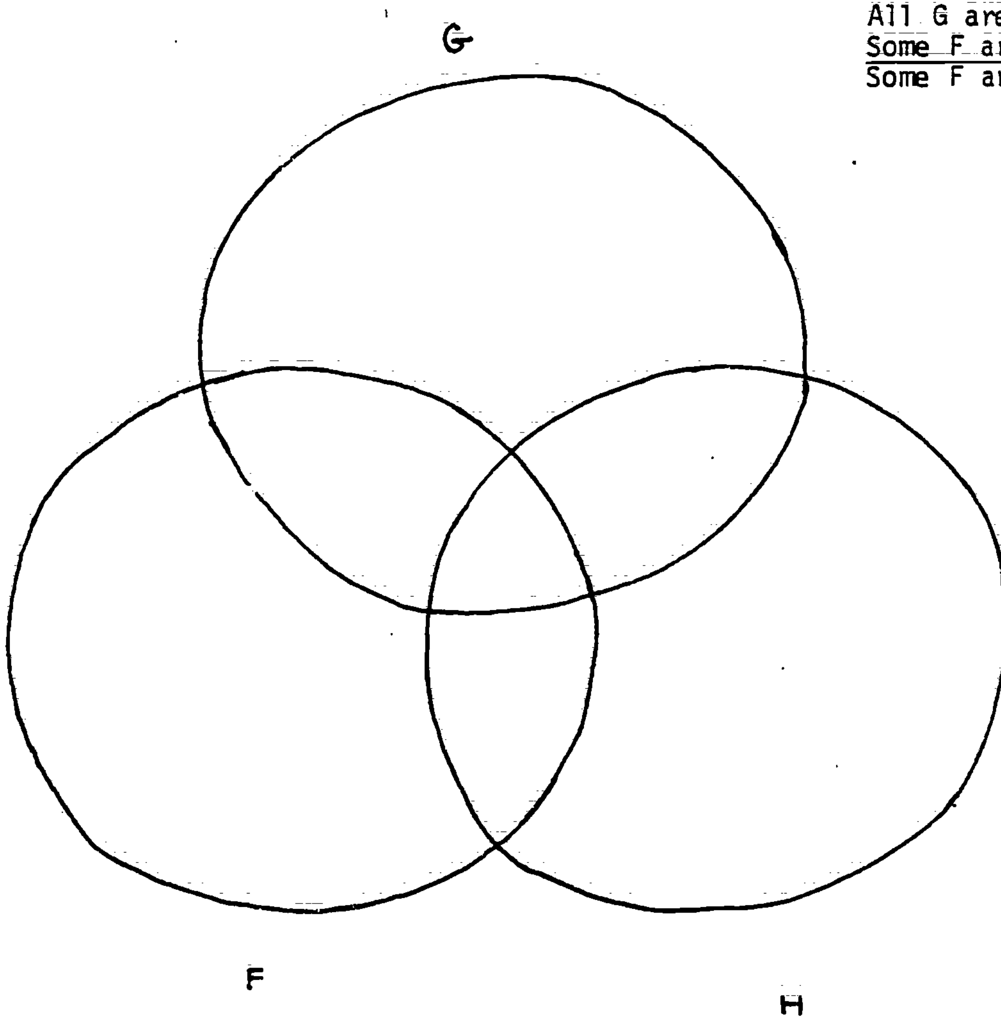
Teaching Suggestions

In lecture, this device could be used to establish the link between categorical sentences and the Venn Diagram.

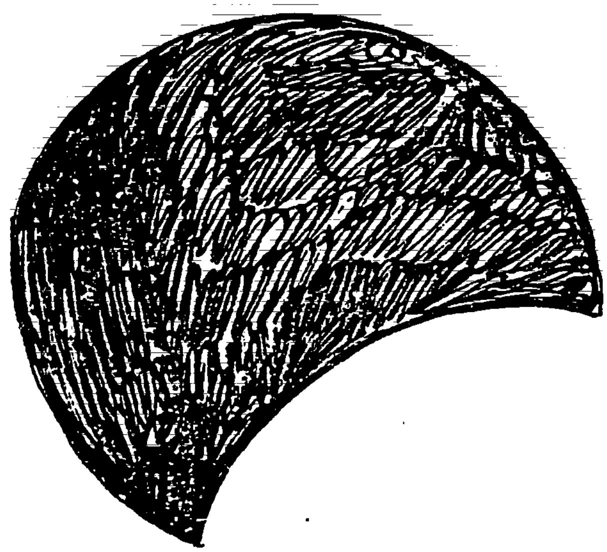
(See diagrams on the next four pages.)

All men are mortal.
Socrates is a man.
Socrates is mortal.

All G are H.
Some F are G.
Some F are H.



Overlay Number One



All G are H.

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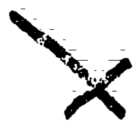
Overlay Number Two



Some F are G.

Overlay Number Three

/

Some F are H.

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FACULTY EVALUATIONS OF THE TECHNIQUES

At the end of the project's final trimester, the instructional devices and techniques in this chapter were presented to available members of the Philosophy Department for evaluation. Their comments are presented here.

1. Philosophical Intuition Survey

   -"This device looks very interesting. It should help the instructor as much as the students."

   -"It looks fine. It should help interest the students from the very first meeting."

   -"The students are likely to be more willing to talk once they have articulated answers to these questions."

   -"The questions are very good."

2. Philosophical Logbook

   -"I certainly think that the idea of marking and writing out difficult passages is good."

   -"If they kept the log regularly, it would really help a lot."

   -"This is much more constructive than simply asking the students about their problems at the end of a lecture. It makes the process of helping them systematic."

   -"This technique will bypass the students' fear of asking 'stupid' questions."

3. Student Participation in Dialectical Reasoning

   -"This is best used in small classes of 15 or so, or in recitations, so the instructor can supervise it properly."

   -"It would be a good component to run for a couple of weeks or so, especially in informal logic or courses dealing with Plato."

   -"If the students like it, it will be very good."

4. Pictorial Representation of Metaphysical Theories

 -"It can make the relationships between things much clearer."

 -"This is an excellent supplement to the lectures and readings."

5. Demonstration to Contrast Different Types of Reasoning

 -"Very good if you have a bit of actor in you."

 -"You should emphasize that inductive and hypothetical arguments can have true premisses and still have a false conclusion."

6. Verbal/Visual Binary Presentation

 -"This is a useful supplement."

 -"It should help make things clearer."

7. Definition exercise for Disambiguation

 -"This is a good spot-remedy for dealing with student problems."

 -"It's certainly a useful thing to do."

 -"A good way to deal with the trouble homophones can cause."

8. Formula Building and Verifying

 -"It's useful, and a good time-saver, too."

 -"It will help the students get clear on grammar."

9. Overlay Transparencies and Worksheets for Interlinear Translation

 -"Students often try to do something like this on their own. This technique will give them systematic guidance.

 -"I like the idea of using overhead projectors for this: you can get the arguments prepared beforehand and avoid wasting class time writing on the board."

 -"I think translation should be done like this, systematically, -- otherwise the students tend to flounder about."

10. Small group Process for Categorization

-"This is good. I like the idea of the students' generating their own English-to-logic lexicon."

-"You could also use this on the board with the whole class, or even as a hand-out for the student to use individually."

11. Translation of Non-truth-functional Operators

-"Students usually have trouble with this concept, but this should help."

-"I like the way students are led to confront the limitations of the truth-functional connectives."

-"This should make the students think more carefully about the logical content of what they read."

12. Invalidity Recognition Through Counter-examples

-"This device makes the topic very clear and straightforward.

-"Very good if you have time for it."

-"I'd like to use this regularly in an informal logic course."

13. Suppressed Premiss Exercise

-"This helps develop a skill that is too often neglected."

-"I like this exercise. It should be used regularly in informal logic."

-"The instructor should emphasize that the added premiss should generate a valid deductive argument, not just a good inductive one."

14. Pictorial Semantics for Categorical Sentences

-"Very dramatic and vivid. The students will really remember it."

-"This should put the point across without getting all tangled up in the semantics of quantifiers and the problem of the material conditional."

15. Transparency Sequence Explaining Application of Rules

-"A clear and useful device."

16. Multi-Colored Transparencies to Illustrate a Venn Diagram

-"You could get through a lot more examples using this."

-"The use of the overhead projector should add vividness."

17. Student Generation of Tableaux Rules for Non-Standard Connectives

-"This gives the students a good idea of how logicians think."

18. Structured Overview for Generating Student Explanations

-"This is the sort of thing that's needed to show the students how to take more effective notes."

-"Students can refer to this when they get lost."

-"The instructor should supervise this carefully."

19. Reverse Reas[illegible] [illegible]ocess for Rule Comprehension

-"This [illegible] [illegible]pecially good for teaching Fitch-style natural [illegible]ion."

-"The reverse reasoning feature of this device connects well with how the rules are actually used.

20. Flow-chart to Illustrate Systematic Reasoning

-"This is easier to use than a verbal description."

-"A good thing for the student to have at his elbow."

A complete evaluation of each technique will require its use by several faculty members. Obviously this press will extend a number of years into the future.

Chapter 9

ADAPTATIONS OF INSTRUCTIONAL TECHNIQUES FOR USE IN OTHER DISCIPLINES

The three disciplines chosen for major attention in this investigation were selected as representative of the broad groups of disciplines--logic from the humanities, physics from the natural sciences, and psychology, classed in this case as being from the social sciences. (The one trimester of work with an English composition course was extra and exploratory; the data from that investigation are listed in Appendix A.) Because of this distribution of the three main disciplines, the instructional techniques collected for use in each one, in many cases, can be adapted for use in other related disciplines. Also, some of the techniques can be adapted to courses in areas quite different from those in which they were demonstrated.

A few suggestions for use by faculty members who want to utilize the techniques in devices in other fields are offered here.

In the Humanities

The items listed below are especially useful in various areas of the humanities.

1. Inductive Learning Demonstration Using Flash-Cards, page 46

   This device can be used to demonstrate the necessity of being motivated in order to learn efficiently. It can be used with any subject where the instructor wants to impress upon students the importance of becoming actively involved in order to succeed. It would be particularly useful in English and foreign languages.

2. Contrasting Designs to Explain a Process, page 48

   The device helps students recognize the importance of good organization of information as an aid in understanding. It would be useful in courses in linguistics, in English writing, and in speech.

3. Structured Overview of a Chapter, page 51

   This is a procedure to help students perceive the relationships of the main and subordinate ideas in a chapter. It is useful in every field.

4. Concept Attainment Technique, page 54

This simple chalkboard procedure can be used to introduce any important new term. It is very useful in every field for presenting terms that are quite strange and that are important enough to justify investing twenty minutes for their introduction.

5. Three-Step Abstraction Process for Teaching a Complex Concept, page 56

This technique requires the use of a series of pictures that illustrate a process to be learned. Students observe each step and generalize the principle involved in the process. It is suitable for teaching a few complex concepts in any field.

6. "Cloze" Technique for Teaching Terms, page 62

A couple of drawings illustrating a set of related terms are used to enhance a lecture; students are provided with a worksheet on which they fill in the terms as a self-testing procedure. This might be especially useful in music, linguistics, philosophy, theater, engineering, library science, and any of the health professions.

7. Transparency with Overlays to Explain Physical Characteristics, page 67

The transparency with overlays can be constructed to show anatomy, musical composition, or stage design. Therefore, it would be very useful in art, in music, and in theater, as well as in other fields.

8. Set of Slides to Illustrate Perceptions, page 72

Sets of slides can be used to lead students to perceive similarities, differences, and sequences in every field of study. In art, slide pictures can illustrate perspective, use of space, techniques for producing rhythm, and other aspects of design. In foreign language instruction they can illustrate similarities and contrasts in cultural values and customs. The ways to use slides in developing perceptions in theater, engineering, business, and the health professions are too numerous to mention.

9. Technical Vocabulary Log for Study Triads, page 76

Students keep a log of difficult technical terms and use a few minutes once every week or two to test each other informally on the terms as they work in groups of three. This technique can be very useful in every field where there is a fairly heavy load of technical vocabulary. It would be a good reinforcer in foreign language study, also.

10. First-Hand Concept Development Experience, page 79

Although the specific experience described here will introduce only one particular concept, other brief experiences can be devised to introduce any number of other concepts. In teaching foreign languages, particularly, words can be pantomimed to clarify and reinforce understanding. The same is true in theater studies.

11. Transparency Pyramid Illustrating a Developmental Process, page 85

This series of transparencies, with one growing out of or fitting over another, can be used to show modifications in any growth process or in any historical sequence. Therefore, devices of this type would be useful in linguistics, music, philosophy, and other fields.

12. Contrasting Experiences to Clarify a Process, page 94

In this situation the students are given an experience in inductive reasoning and one in deductive reasoning in order to clarify the differences in processes. Similar contrasting experiences can be devised to teach such things as differences in language structures, differences in literary forms, differences in musical forms, differences in art techniques, and differences in many other areas. Consequently, the technique is useful in most fields.

13. Self-Testing Technique to Foster Comprehension, page 96

This procedure provides students with a limited time to study a set of concepts on two pages from the text, then gives them a short check-test on their learning. It commands their full concentration and helps them perceive exactly how successful they are in study. It can be very useful in every field that has a body of content to be learned.

14. Folding Chart, page 104

This is a simple chart to illustrate how a cognitive process is transformed into an overt behavior. Charts of this type can be prepared easily to clarify any process that is more easy to understand when a visual dimension is added to the verbal explanation. In art, it could be used to explain the transformation from conceptualization to visual form. In language studies it could be used to illustrate the change in meaning or pronunciation of a word from an earlier time to a later time; certainly something like the great vowel shift in English could be clarified this way. Before-and-after changes can be illustrated with such a chart in art, theater, philosophy, and other fields.

15. Transparency Summarization Set, page 106

This base transparency with overlays summarizes and relates key ideas about a developmental process. This type of transparency set is commonly used in all fields of instruction.

16. Expanding Chart, page 108

This chart expands vertically in folds to show stages in a developmental process. It is suitable for use with any explanation that begins at a base level and moves upward in stages.

17. Transparency Set to Abstract Key Concepts, page 110

Like the transparency summarization set, this device begins with a base transparency and with overlays to add essential summaries of information for different stages of a process or a developmental sequence. It adds, however, additional overlays on which large writing is used to show the key point that can be abstracted from each brief explanation. This procedure is useful in leading students to distill crucial points from explanations in philosophy, fine arts, library science, and most other fields.

18. Peer Group Interaction to Induce a Set of Concepts, page 133

Students work on definitions of terms or processes in small groups and then rotate group membership to share and refine the definitions. This technique is suitable in any field where a number of technical terms must be learned.

19. Structured Summary Block Design, page 136

A "modular block" of content is presented to students; it consists of lists of summary statements about the content. The students differentiate among main ideas and supporting details, then arrange them in the right order. This procedure for organizing their thoughts would be useful in the classics, in linguistics, in philosophy, and in library science, as well as in other areas of study.

20. Pocket Chart to Portray Analogous Terms, page 160

This pocket chart permits rapid construction of analogies by slipping the cards that display various terms into the charts. Such use of analogies can be useful in teaching foreign languages, English literature, speech, and library science.

21. Illustrated Question Sequence to Develop Concepts, page 171

This device is used to help students obtain understandings of the differences between "ordinary" words and the same words used as technical terms. The differences are contrasted with drawings and pointed questions in order to help students remember. The device would be useful in teaching art, classics, linguistics, music, and library science.

22. Semantic Differentiation of the Properties of a Term, page 184

The term to be learned is stated above a series of scale lines having polar opposites at the ends. Students try to select the point between the polar qualities that best describes the target term on each scale. This helps to make their understanding of the term more precise. The device is useful in every area of study.

23. Philosophical Intuition Inventory, page 210

The students are given a short-answer questionnaire that asks them to give their views on a variety of issues. The procedure provides a "mental scaffolding" for a course and can be useful to both the students and instructors at the beginning of classes in art, classics, literature, music history, theater, and foreign languages.

24. Student Participation in Dialectical Reasoning, page 216

Students work in triads, having three technical terms or rules assigned. They take turns explaining one of the ideas, and the other two students lead them through Socratic questioning to make the explanation more complete as needed. The technique is useful in all areas of study.

25. Invalidity Recognition through Counter-Example, page 240

Students are given a list of statements about a particular principle or theory. Some of the statements are valid, while others appear valid if the student does not have a clear understanding of the principle or theory. Students try to determine which statements are valid, which ones are inaccurate, and which ones are the opposite of the theory. They discuss their reasons for responding the way they do. This technique is useful in every area of study where theories and principles are presented.

Among the five dozen techniques and devices described in Chapters 4, 6, and 8, instructors will discover a number of others that can be adapted for use in the humanities.

In the Social Sciences

The items listed below are especially useful in the social sciences and in social work, professional education, business, and law. Many are the same as those recommended for the humanities, but some are different.

1. Philosophical Intuition Inventory, page 210

   The students give their views on issues to be discussed in the course by responding to a short-answer questionnaire. This provides a "mental scaffolding," or orientation, for class discussions which can be useful in studying history, economics, political science, sociology, social work, professional education, business, or law.

2. Philosophical Logbook, page 212

   The student prepares a weekly three-page log of problems related to a course. On the first page he/she notes problem terms, issues, and concerns that need clarification. On the second page he/she gives responses found in texts or references. On the third page he/she tapes clippings from current newspapers and magazines related to the topics or problems. This technique would be particularly useful in political science, sociology, and professional education.

3. Definition Exercise for Disambiguation, page 226

   Students are given a worksheet on which the instructor has listed groups of terms that often are confused. In the spaces provided the students write the definitions, underlining the portions that make one term different from another. This is useful in every field of study.

4. Multicolored Transparencies of Venn Diagrams, page 254

   Venn diagrams are used to show overlapping of influences on any event. If the diagrams are colored in certain ways, additional colors will appear where there is a double effect. (Blue and yellow will produce green, if the colors are clear.) This device would be useful in economics, business, and professional education.

5. Student Participation in Dialectical Reasoning, page 216

   Students are assigned three technical terms, rules, or theories to discuss in triad groups. Each takes a turn explaining one of the ideas, and the other two students consider whether the explanations are complete. If not, they lead the first student by Socratic questioning to state the idea more fully and accurately. This technique should be useful in anthropology, economics, history, political science, sociology, business, law, social work, and professional education.

6. Inductive Learning Demonstration Using Flash-Cards, page 46

Students spend about one minute in learning to associate several short words with numbers. Then they discover that they did not do as well in incidentally learning the colors on which the numbers were written. This should impress upon them the importance of having their clients motivated to learn--intending to learn. The device is particularly useful in teaching business, social work, and professional education, as well as the related disciplines.

7. Contrasting Designs to Explain a Process, page 48

Students are asked to learn to designs that are exactly alike in content, but very different in arrangement. From this experience they learn the importance of good organization of information to develop understandings. The device is useful in every discipline and in every area of professional study.

8. Structured Overview of a Chapter, page 51

A chapter's structure is shown by use of an outline or a diagram; this helps students see the relationships of main and supporting ideas. It is useful in every discipline and professional field.

9. Concept Attainment Technique, page 54

Students look at an entirely new term on the chalkboard and ask questions in trying to understand it. As the instructor answers "yes" or "no" to the questions, the meaning of the term begins to emerge. This technique is useful in every field for terms that are important enough to spend twenty minutes on in class discussion. It would not be used frequently, but would have a strong novelty value in teaching.

10. Diagrammatic Representation of an Explanation, page 58

This device involves use of a base transparency of a figure (normal curve, in the illustration), with overlays that change the distribution of materials within the figure. Such a device could be constructed for use in economics, business, professional education, and possibly other fields.

11. "Cloze" Technique for Teaching Terms, page 62

A lecture is illustrated with one or more drawings that show important technical terms. Then students are provided with a worksheet showing a paragraph with the terms omitted (terms are listed below). They insert the terms in the correct blanks and check their own answers from another transparency. It appears that this device would be very useful in anthropology, sociology, economics, business, law, social work, and professional education.

12. Accordion Chart Illustrating Language Style, page 74

The two charts that are shown are used to explain "removed in time" and "removed in space." Other charts of this type could be developed to show idiomatic expressions in foreign languages and unique expressions that are common to economics, sociology, social work, professional education, and law. Each of these fields has a number of examples of "professional phraseology" that can mystify students if not illustrated in some way or contrasted with more familiar expressions.

13. Transparency with Overlays to Explain Physical Characteristics, page 67

A base transparency showing the general outline of any object can be provided with overlays showing and labeling specific parts. This device is useful in anthropology, history, political science, social work, professional education, and other fields.

14. Technical Vocabulary Log for Study Triads, page 76

Once every week or two students are divided into groups of three to study and test each other on technical terms they have been keeping in a daily log. This technique is useful in every field having a number of terms to be learned.

15. Quick Demonstration of a Psychological Function, page 78

The instructor can personally demonstrate or arrange for a student to demonstrate such things as the class reaction to having one member severely scolded, the reaction to flattery, the reaction to a biased statement, or the reaction to a particular type of drawing. Such a demonstration would be useful in teaching political science, sociology, social work, business, law, or professional education.

16. Mini-Experiment to Demonstrate a Concept, page 80

Brief informal experiments can be provided to demonstrate such things as ESP, mnemonic devices, effectiveness of different forms of argument, or the presence of different points of view on a topic. These illustrate an idea much more fully than words alone, and are useful in teaching most of the social sciences and related professions.

17. Transparency Pyramid Illustrating a Developmental Process, page 83

A series of transparencies, with one fitting over another, can be used to show modifications in a growth process or in a historical sequence. Devices of this type can be constructed for use in anthropology, economics, history, sociology, political science, business, social work, and professional education.

18. Contrasting Experiences to Clarify Processes, page 94

Here the students are guided in classroom experiences that are distinctly different. For example, they might have a brief experience in cooperation vs. one in competition or discrimination, one in low-key argument vs. one in high-pressure argument, or others of a more technical nature. This technique, it appears, would be useful in economics, political science, sociology, social work, business, law, and professional education.

19. Self-Testing Technique to Foster Comprehension, page 96

The students are provided with a limited time to study a set of concepts on two pages from the text, then given a short, non-graded check-test. This commands their full concentration and helps them understand exactly how successful they are in study. It can be useful in every field, especially on pages where careful concentration is needed.

20. Folding Chart, page 104

This simple chart illustrates how a cognitive process is transformed into an overt behavior. Charts of this type help students greatly when the textbook wording is heavily concept-loaded. It also can be used to show changes in a situation through different periods of time. Consequently, it would be useful in teaching anthropology, history, sociology, business, and professional education.

21. Expanding Chart, page 108

This chart expands vertically in folds to show the stages in any developmental process. It would be particularly useful in anthropology, sociology, political science, social work, or professional education.

22. Transparency Set to Abstract Key Concepts, page 110

This device has a base transparency with overlays that summarize essential information in steps or stages. It adds additional overlays on which large writing is used to show the key point that can be abstracted from each of the brief summaries. This process is useful in leading students to distill crucial points from explanations in every discipline and field of professional study.

23. Accordion Charts Presenting Heuristic Strategies, page 127

The charts show different sequences of steps in heuristic problem-solving. They can be useful in a number of areas of instruction.

24. Structured Summary Block Design, page 136

A list of main ideas and supporting statements on a particular block of content is given to the students in mixed order. They work individually or in small groups to sort the statements into proper sequence. This procedure is useful for helping students organize their thinking in every field of study, especially as a review activity.

25. Etymological Charting of Technical Terminology, page 158

The historical development of the meaning (and perhaps the pronunciation) of a term is charted on a timeline illustrated by pictures or diagrams. This additional experience using a second mode of perceptual input makes a strong impression on the student's memory. It is useful in every field of instruction.

Instructors in the social sciences and related professional fields will find a number of other techniques that they can use in Chapters 4, 6, and 8.

In the Natural/Physical Sciences

The techniques and devices listed below are especially useful in the natural sciences, in engineering and in the health-related professions. Because some techniques are useful in every field of instruction, the ones listed here will duplicate some of those mentioned earlier in this chapter.

1. Critical Attribute List to Define Technical Terminology, page 144

   Students bring with them to a learning situation prior knowledge which can assist or hinder in the understanding of a concept. The technique described on page 144 helps the student differentiate between attributes which do not directly relate to the technical definition. Instructors in any field that includes terms having dual meanings may want to utilize this technique.

2. Rating Scale to Differentiate Between Technical Terms, page 164

   Technical terms that appear to be similar on the surface may have shared qualities that actually differ. The rating scale technique helps students to see how two similar terms contrast on specific qualities. It may be used in many courses, for example in the health-related professions to differentiate between various symptoms of diseases or in geology courses to point out the differences in metamorphic, sedimentary, or igneous rocks.

3. Paired Comparison Technique for Concept Clarification, page 188

   In many units the concepts under study can be organized into a hierarchical classification system which demonstrates how the terms relate to one another. The paired comparison technique leads students to analyze and compare definitions of a number of concepts so that they can be grouped in hierarchical fashion. It can be used in any science or science-related course which covers classification systems or well-ordered units of study.

4. Accordion Charts Presenting Varied Heuristic Strategies, page 127

   These accordion charts expand vertically with each cell representing a single step in a heuristic strategy. Students are able to review several different methods of solving problems and are urged to adapt a system which best meets their needs. The use of accordion charts would be of value to students enrolled in mathematics (word problems), statistics (statistical design), and chemistry (procedural steps). Of course, students will need ongoing practice with a chosen strategy if they are to become fully competent in its use.

5. Peer Group Interaction to Induce a Set of Concepts, page 133

Research has demonstrated that peer group learning activities are particularly helpful for students enrolled in science classes. This peer-teaching technique draws upon peer group teaching experiences to develop precise definitions and explanations for concepts covered in class. It leads to active learning that involves all the members of the class or recitation section.

6. Etymological Charting of Technical Terminology, page 158

Scientific terms can often be traced back over the years to origins in Latin or Greek. The etymological charting device graphically charts the etymological development of a technical term. It can be utilized in virtually every science class.

7. Structured Summary Block Design, page 136

The students are given a list of main ideas and important details pertaining to a section of the text. They work individually or in small groups to sort the statements and technical terms into the proper blocks. The completed block design serves as a valuable retrieval chart in reviewing for exams. This technique can be used with any subject matter and as homework once the students have mastered the technique.

8. Semantic Differentiation of the Properties of a Term, page 184

Definitions of technical terms in the scientific fields tend to be rather precise with commonly accepted semantic boundaries. Technique number 8 leads students to develop a precise understanding of any term to be mastered. Students try to select a scale point between polar qualities that best describes a target term. Several sets of polar qualities are represented for each term.

9. Philosophical Logbook, page 212

Logbooks can be utilized in various science courses, particularly those advanced courses concerned with major thematic issues. This multipurpose technique is designed: (1) to help students identify comprehension difficulties, (2) to promote class discussions, and (3) to encourage the application of course concepts and theories to "real world" situations. The technique is used throughout the school term and serves as the basis for diagnostic teaching.

10. Flow-Chart to Illustrate Systematic Reasoning, page 252

Many processes can be made more comprehensible by presenting them in forms other than expository text. Flow-charting has been found to be an effective alternative method for presenting this information. After students learn how to read a flow-chart, they can be taught to develop their own for study purposes.

11. Structured Overview of a Chapter, page 51

This procedure should be used at the start of a new unit of study. The instructor introduces the most important main and subordinate ideas by briefly defining them and organizing them in a structure diagram that leads students to perceive relationships. Research has proven that this technique is successful in classes such as mathematics and biology.

12. Transparency with Overlays to Explain Physical Characteristics, page 67

The transparency with overlays can be constructed to demonstrate botanical and zoological structures, geological time periods or formations, meteorological forces, etc. Therefore, the device can be used in virtually all natural science or physical science classes, as well as in engineering and the health-related professions.

13. Technical Vocabulary Log for Study Triads, page 76

Technical vocabulary terms have been identified as the most common receptive communications problem by the students participating in the Languages of the Disciplines Project. One method for helping science students overcome such problems is to have them keep a log or card file of difficult technical terms. On a bi-weekly basis the students are urged to informally test one another to permit them to monitor their comprehension of these terms.

14. Verbal/Visual Binary Presentation, page 224

Many receptive communications problems associated with technical terms can be clarified by presenting the concept through discursive and pictoral modes. With the verbal/visual binary presentation, the instructor first provides a written definition or explanation for the term and then presents a pictoral representation (schematism, diagram, photograph, etc.) of the same concept. Finally, the two representations are related to each other through color-coded highlighting, underlining, etc. The technique would be appropriate for presenting formulae in mathematics, statistics, or chemistry classes.

15. Manipulative Model to Contrast Terms, page 162

Models are regularly used to demonstrate concepts in science courses. The device shown on page 162 shows how simple materials can be used to construct manipulative models that demonstrate several aspects of a concept. This type of device can be used in most courses for the sciences, health-related professions, and engineering.

16. Student Participation in Dialectical Reasoning, page 216

Students are assigned to study group triads that meet throughout a term on a regular basis. The course instructor assigns three previously identified problematic language components to the groups for study. Then after researching the material, one student explains an idea while another asks questions and probes for further clarification. The third student records the important points in a logbook. The roles are rotated for each idea being discussed. This technique can be used in virtually all classes or recitation sections. A variation which can be used in more advanced classes would be to assign a single difficult problem that has several possible methods of being solved.

17. "Cloze" Technique for Teaching Terms, page 62

During a lecture the instructor uses an overhead projector to show the class an illustration or diagram without the proper labels for the component parts, e.g., the structure of a cell. The students are given worksheets with a paragraph that explains the structure; however, the major terms (labels) are omitted (terms are listed at the bottom of the sheet). As the lecture procedes, the students insert the correct terms in the blanks and check their answers by viewing another transparency. This device would be useful in courses such as biology, zoology, anatomy, botany, etc.

18. Concept Attainment Technique, page 54

The instructor writes a new term to be clarified on the chalkboard. The students ask questions in trying to understand it. As the instructor answers the questions with simple "yes" or "no" answers, an understanding of the term begins to emerge. This technique can be used in most science classes, but because of the time factor involved (20 minutes) it should be used with important terms that might otherwise be misunderstood.

19. Transparency Pyramid Illustrating a Developmental Process, page 83

A series of transparencies, with one fitting over another, can be used to show modifications in a chemical process or geological time sequence. Devices of this nature can be developed for use in biology, zoology, chemistry, geology, astronomy, mathematics, and health-related professions.

20. Three-Step Abstraction Process for Teaching a Complex Concept, page 56

This technique utilizes a series of pictures or diagrams that illustrate a process to be learned. After viewing each step, the students generalize the principle involved in the process. It can be used for teaching complex concepts in most science, health-related, or engineering courses.

21. Diagrammatic Representation of an Explanation, page 58

This device involves use of a base transparency of a figure with overlays that change the distribution of material within the figure. Such a technique can be constructed for use in physics, biology, engineering, statistics, mathematics, chemistry, etc.

22. Accordion Chart Illustrating Language Style, page 74

In each field there are examples of "professional phraseology" that can lead the student to have learning difficulties. Often these problems can be overcome by illustrating, or comparing and contrasting the language styles with familiar experiences. An accordion chart can be a successful device for introducing unique language styles in science classes.

23. Philosophical Intuition Inventory, page 210

The students are given a short answer questionnaire which leads them to describe their views on various issues which will be covered in class. The technique leads the students to develop a "mental scaffolding" that calls forth prior knowledge (as well as misconceptions) about varied topics. The instructor can review the inventory sheets as a diagnostic activity. The technique can be used in any science course which deals with topical issues.

24. Self-Testing Technique to Foster Comprehension, page 96

Each of the students is given two textbook pages consisting of a set of potentially problematic concepts to study for a limited time. The students take a short, non-graded check-test and are also asked to predict their performances on the test. Then the actual results are compared with the predictions. This technique allows each student to realistically judge how successful he or she is in studying a certain type of material. Throughout the term the instructor can make suggestions on how the members of the class might monitor their comprehension of the various problematic language components that are presented in the course.

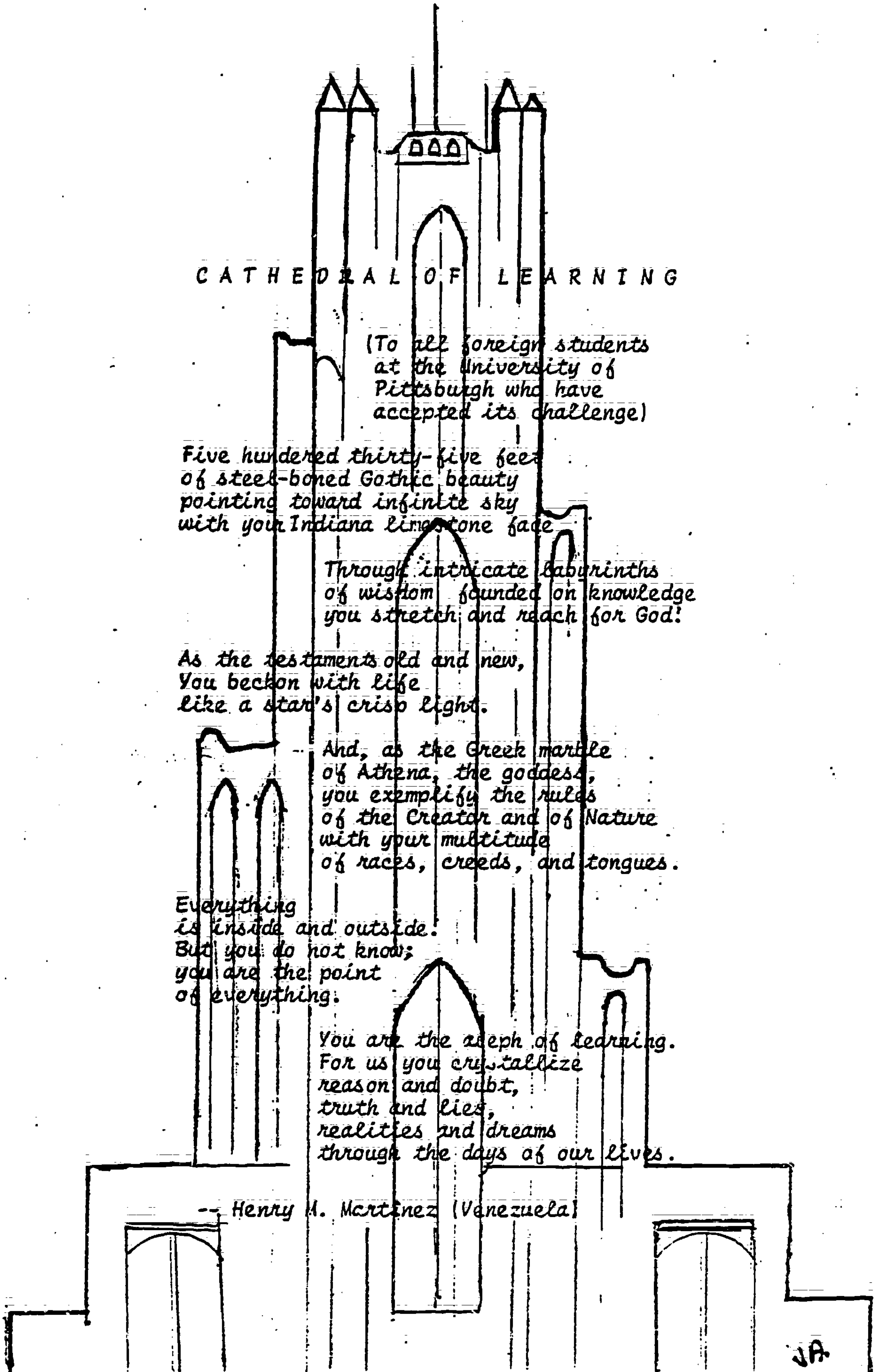
25. Expanding Chart, page 108

- This chart expands in a vertical manner to show (1) stages in a process, (2) steps in an experiment, and (3) events in a historical sequence. It is suitable for use with any explanation that begins at a base level and moves forward in stages.

The Challenge

Life is growth. Every excellent teacher seeks to grow throughout his or her whole career by multiplying and refining his or her cache of instructional procedures. The techniques and devices described in this manual are offered in the hope that many college and university professors will find one or two, perhaps three or four, that will enhance their students' learning. And perhaps these experiences will enlist some faculty members in evaluating the techniques and in sharing their favorite ideas that have not been included here.

The challenge is to seek the greatest rewards in the life of a teacher by helping others, young and old, to become more enlightened. A symbol of that challenge is the Cathedral of Learning at the University of Pittsburgh as described by a student from another country on the following page.



C A T H E D R A L O F L E A R N I N G

(To all foreign students
at the University of
Pittsburgh who have
accepted its challenge)

Five hundred thirty-five feet
of steel-boned Gothic beauty
pointing toward infinite sky
with your Indiana limestone face

Through intricate labyrinths
of wisdom founded on knowledge
you stretch and reach for God!

As the testaments old and new,
You beckon with life
like a star's crisp light.

And, as the Greek marble
of Athena, the goddess,
you exemplify the rules
of the Creator and of Nature
with your multitude
of races, creeds, and tongues.

Everything
is inside and outside.
But you do not know;
you are the point
of everything.

You are the aleph of learning.
For us you crystallize
reason and doubt,
truth and lies,
realities and dreams
through the days of our lives.

-- Henry M. Martinez (Venezuela)

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APPENDIX A

RECEPTIVE LANGUAGE PROBLEMS

E N G L I S H   G E N E R A L   W R I T I N G

The numbers of reading and listening difficulties experienced by a small experimental group (eight students) from an introductory English course in general writing during the Fall trimester of 1981 were as follows:

	Total Problems	Serious Problems
Technical Vocabulary	88	41
General Vocabulary	74	9
Explanations of Principles And Generalizations	51	18
Metaphors of the Discipline	22	4
Specialized Language Style Factors of the Discipline.	2	0
Complex Sentence Structures.	0	0
Special Symbols.	3	1

The largest number of difficulties noted by the students was in technical vocabulary. A large number of general vocabulary terms were also listed; however, most of these did not present a serious problem to the students. As might be expected, there was a greater number of metaphorical or figurative lanaguage elements identified as problems in this English course than in the other disciplines under study. Nevertheless, it appears that only a small number of these caused the students major problems.

The problems encountered in the experimental group from the general writing class are itemized below. The classification of an item as technical vocabulary, general vocabulary, metaphor, etc., had to be based on somewhat subjective judgement, so other educators may prefer to classify some items differently. Those problems that seemed to be serious problems because they were classed as difficult by twenty percent or more of the group are starred.

TECHNICAL VOCABULARY IN GENERAL WRITING: THE DIFFICULTIES NOTED

accusative
analogical assertions
analogy
*antecedent
*APA guide
*argot
audience
cant
*case
*colloquial writing
comma splices
common derivation
communication patterns
conjunction
connotation
*dangling modifier
*dative
diction
*direct object
divergent variants
effective connotations
ellipsis
etymological
excess verbiage
*formal language
*formal writing
fragment
*future perfect tense
*grammar
homographs
homonyms
*homophone
iambic
ibid.
*imperative form
*inflection
*informal language
*irony
*jargon
lexicon
lingo
linguistics
*melioration
*metaphor
MLA guide
*noise
*nominative
non sequitur
nonstandard usage
objective pronouns
*orthography
*past tense
*past perfect tense
patter
*pejorative
predicate nominative
prefixes
*present tense
proofreading
prose
*refereed journal
*regular verbs
*rhetoric
rhetorical statement
run-on sentence
*sic
*simile
slang
style
style sheets
subjective connotations
subjective pronoun
*subjective mode
*syllogism
*syntax
*tautology
tense shift
tone
transition
*transitional adverb
*transitional elements
trite language
*Turabian's <u>A Manual for Writers</u>
usage
verb/adverb combination
*vernacular

GENERAL VOCABULARY USED IN GENERAL WRITING: THE DIFFICULTIES NOTED

abstract
abstraction
amplification
affect vs. effect
antiphony
aptly
augury
bad vs. badly
between vs. among
*categorical analysis
clarity
cognitive
comparative basis
concepts
conducive
contingency
contractions
convection
countenance
covertly
crotchety
culminate
*cult
curatorial position
curricular change
*deductive reasoning
dilettante
disconcerting
*dogmatic
eccentrically
eliminate
*en brosse
*euphemism
extremely suspect
fallacy
fatuousness
garrets
generalization
ghastly objectivity
glamour
implementation
inclination
incremental
*inductive reasoning
infliction
interminable
labyrinth
limiting
*logic
meaning of meaning
monolithic
musical score
oratory
originality
ostensibly
*paradox
permeate
platitudes
pontificating
positivistic
pretension
profundities
prowess
reasoning
Renaissance
rote
rules and regulations
ruthless
sibling
social ostracism
succinctly
tacky
vague words

EXPLANATIONS OF KEY PRINCIPLES, GENERALIZATIONS, OR COMPLEX CONCEPTS IN GENERAL WRITING: THE DIFFICULTIES NOTED

American Indian language
apostrophe, use of
Art of using the English language
bibliography, how to construct one
*cause-effect style of writing
*classification style of writing
*colon, use of
*conjugation of a verb
*definition style of writing
*description-analogy style of writing
developing ideas in writing
development of a paragraph
*direct quotation versus indirect quotation
*division style of writing
*Elizabethan times
final statement, development of
footnotes, use of
"for" at the beginning of a sentence as a conjunction
*Germanic languages
*Indo-European family of languages
italicized words underlined in writing
"It is easier to learn language by the rules."
"Justify changing a tense within a paragraph."
"Know who you are writing for; know your readers."
"Language is a function of time."
level of language usage
nature of word order in the English language
noun/pronoun agreement
oral literature
Oxford English Dictionary, use of
parallels in various languages
*parentheses, how to use
poetry before prose (historically)
printing press' importance in history
realities of communication
revision step, explanation of
*Roman numerals in prefaces, outlines, appendices
semicolon, a weak period
sentence structure
seven forms of English verbs (2)
*sexist language
Shakespeare's lake county
strategies for writing
Stuart-Tudor period
*thesis statement, how to develop
"to be", the forms of
*transitional paragraph
usage levels--formal, informal, colloquial
utilization of technical language versus "plain" English
*weak passive voice
*"Words are used to convey experience."

METAPHORS USED IN GENERAL WRITING: THE DIFFICULTIES NOTED

"Act like you are writing or talking to a blind person."

"Be a lot leaner in your approach."

*"Can't light your fires if you don't have fires to light."

"Dumas was robustly built with a body like a bill hook."

"Eliminating wordy words is justifiable abortion."

"Extend yourself extensively."

"Feel for how to convey the idea."

heavy-handed approach

"How pale the moon though climbest the midnight sky."

"I went out of tree."

illegitimate legitimacy

*loaded terms

penetrate his universe

power of speech

the flotsam and jetsam of excess words in a paragraph

*the voice of the paper

"There will be no lightening bursts of metaphoric brilliance or dense pursuit of abstract profundities."

three tries for a dollar

"We murder to dissect."

writing cold

"You must have an ear for the English language."

*"Your words and sentences must flow in your essays."

LANGUAGE STYLES OF GENERAL WRITING: THE DIFFICULTIES NOTED

Formalize the verbs to standardize the language.
"You are writing or communicating with an unseen audience."

SPECIAL SYMBOLS USED IN GENERAL WRITING: THE DIFFICULTIES NOTED

*[ ]
( )
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APPENDIX B

Student Difficulties Log Form

APPENDIX B

Languages of the Disciplines Project
Language Difficulty Data Collection

Sheet 1

STUDENT ______________________ SUBJECT ______________________

Week beginning ______________________

Chapter/pages covered in text ______________________

KEY PRINCIPLES, THEORIES and COMPLEX CONCEPTS
(stated as sentences or paragraphs)

Difficult New Ideas	Explanation	Type of Difficulty: New Idea	New Meaning	Old Term	Term Confused	Lecture	Textbook (Page No)	Other	Solution Found: Class Lecture	Reread Text	Ask Instructor	Recitation Sec.	Dictionary	Lang. Study	Reasoning

heet 2

Languages of the Disciplines Project

MENTS:

Difficult New Ideas (words and phrases)	Definition	Type of Difficulty: New Term	New Meaning	Old Term	Term Confused	Lecture	Text (Page#)	Other	Solution Found: Class Lecture	Reread Text	Ask Instructor	Recitation Sec.	Dictionary	Ling. Study	Reasoning

Languages of the Disciplines Project

STUDENT________________ SUBJECT________________

Week beginning________________

Difficult New Ideas	Definitive/Explanation	Type of Difficulty: New Term	New Meaning	Old Term	Term Confused	Lecture	Text(Page #)	Other	Solution Found: Class Lecture	Reread Text	Ask Instructor	Recitation Sec.	Dictionary	Lang. Study	Reasoning

ut 4 Languages of the Disciplines Project

NTS:

Difficult New Ideas	Explanation	Type of Difficulty: New Term	New Meaning	Old Term	Term Confused	Lecture	Textbook(Page No)	Other	Solution Found: Class Lecture	Reread Text	Ask Instructor	Recitation Sec.	Dictionary	Lang. Study	Reasoning	Other

APPENDIX C
ABSTRACT

LANGUAGES OF THE DISCIPLINES PROJECT
University of Pittsburgh

The often-mentioned explosion of knowledge has provided a constant flow of information and new vocabulary that students need for success in studying in each academic discipline. Many potentially competent college freshmen encounter a great gap between their current levels of reading and listening skills and the levels required in their introductory college classes.

To help bridge this gap a project team at the University of Pittsburgh, supported by the Fund for the Improvement of Postsecondary Education, developed and tested a procedure for identifying students' receptive communication (reading and listening) skill difficulties in various university disciplines and for overcoming them.

Model. As the model evolved, it included these major steps:

(1) Establishing informal hypotheses about the types of difficulties that are likely to be encountered and effective procedures to overcome them.
(2) Selecting experimental students and faculty,
(3) Gathering data on student difficulties through language study sessions,
(4) Refining the data and procedures through faculty involvement,
(5) Seeking solutions to the communications difficulties,
(6) Testing and refining the tenative solutions, and
(7) Sharing the results with other educators.

Project initiation. In addition to the co-directors, project personnel included a research associate, three teaching assistants, a part-time secretary, an associate provost as consultant, two outside evaluators, and a group of cooperating professors in physics, philosophy, and psychology (and for one trimester, English). For three trimesters teaching assistants monitored introductory courses as if they were beginning students and met weekly in language study sessions with fifteen students from each class to maintain and discuss logs of language difficulties students encountered. They conferred regularly with cooperating professors and others in the departments about the student difficulties and solicited suggestions from professors for overcoming the problems.

Receptive language difficulties. Types and numbers of receptive communication difficulties encountered by students are listed below, where TP = total problems and SP = serious problems.

	Philosophy TP	Philosophy SP	Physics TP	Physics SP	Psychology TP	Psychology SP	English Comp. TP	% of all SP
Technical Vocabulary	77	37	148	54	299	79	88	62
General Vocabulary	36	10	43	13	58	9	74	12
Explanations of Principles, Theories, Generalizations	42	30	29	7	72	12	51	18
Metaphors in the Discipline	3	3	13	3	14	2	22	3
Specialized Language Style Factors of the Discipline	5	5	3	0	7	1	2	2
Complex Sentence Structures	5	5	2	0	10	4	0	3
Tabular, Graphic, Symbolic Materials	0	0	3	0	4	1	1	0

Observations about students' problems. The participants noted several facts about students' problems, including: (1) Technical vocabulary is by far the greatest difficulty in introductory courses, (2) General vocabulary is another problem requiring continuing study, (3) Problems with explanation of key principles and theories are very serious, because a student who fails to understand a key idea can find this a block to other understandings, (4) Difficulties with metaphor and specialized language styles are less numerous, but should not be overlooked, especially in more advanced courses, (5) Sentence structure problems are minimal in a university having fairly high admission standards. In addition,it was noted that students have special difficulties with words that have common every-day meanings, but different technical meanings. Also, students often mistakenly think they understand a principle if they can repeat or paraphrase it from memory. If the disciplines studied here are typical of all the disciplines, college instructors can expect that the serious reading problems for each language factor will occur in the proportions shown in the last column of the table.

Providing solutions for difficulties. During one full trimester and parts of others, the team consulted professors, references, and colleagues while developing a collection of approximately eighty instructional techniques and devices for use with students to overcome many of the communications difficulties itemized. Instructional techniques included such things as advance organizers, structured induction, reverse reasoning, and semantic mapping, while instructional devices included hierarchy charts, manipulative models, special transparencies, and many more. During another trimester the language study group leaders (teaching assistants) tried out the instructional procedures on students from the regular courses enrolled in small study groups. Then in the final trimester the team assisted the regular professors and teaching assistants in utilizing the materials with students in regular classes in two disciplines. In the third field (psychology) a small comparative study was undertaken, the results of which will be reported elsewhere.

Project evaluation. Because the class sections were taught each term by different professors, often using different syllabi, different textbooks, and different methods, it was impossible to make rigorously controlled comparisons of effects of the "new" instructional techniques and devices. Outside evaluators, however, have used student data sheets, questionnaires, and interviews to evaluate progress. They have found that students have been enthusiastic about learning experiences in the small group sessions. Also most of the seven professors who have taught the monitored classes have felt the findings about students' difficulties and the proposed instructional techniques were useful.

Project dissemination. Nearly 1500 copies of a 27-page monograph describing the project have been distributed to faculty members in more than 200 colleges and universities, some by mail and others at presentations made at approximately twenty professional conferences and workshops. The project has been described in journals and newsletters. Finally a 285-page manual, Teaching Techniques for the Languages of the Disciplines, has been distributed, in limited numbers. It itemizes all student difficulties and describes 66 of the instructional suggestions. Persons desiring more information or assistance in adapting the model to their situation may contact Dr. Harry W. Sartain, School of Education, 4H01 Forbes Quadrangle, University of Pittsburgh, Pittsburgh, PA, 15260 (Telephone (412) 624-6185) or Norman A. Stahl, Division of Developmental Studies, P.O. Box 872, Georgia State University, Atlanta, GA, 30303 (Telephone (404) 658-3361)