THE EFFECT OF PRESENTATION ORDER OF POSITIVE AND NEGATIVE INSTANCES ON CONCEPT LEARNING

BY

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by

Barbara Kimbrough Hays

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To the Graduate Council:

I am submitting herewith a Research Paper written by Barbara Kimbrough Hays entitled "The Effect of Presentation Order of Positive and Negative Instances on Concept Learning." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts in Education, with a major in Guidance and Counseling.

Elizabeth H. Stokes
Major Professor

Accepted for the Council:

Wayne E. Stamper
Dean of the Graduate School

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INTRODUCTION

We live in an age in which, more than in any other time in history, the public and educators alike demand the best education for the greatest population using the most efficient methods possible. Concepts are the building blocks which form the basis for all learning and therefore for all educational processes. This study was an attempt to find new information which might be useful in solving the problem of how to teach concepts more efficiently in the classroom.

Statement of the Problem

It was the purpose of this study to compare the effect of presentation order of positive and negative instances on concept learning related to conic sections. Subjects were compared by using statistical analysis of data on the following basic areas of concept attainment: (1) parabola, form of graph; (2) parabola, form of equation; (3) circle, form of equation; (4) ellipse, form of graph; (5) ellipse, form of equation; (6) hyperbola, form of graph; and (7) hyperbola, form of equation.

Purpose of the Study

Although much research has been conducted in the field of concept learning, published experiments differ in their findings as to the relative efficiency of the presentation of positive and then negative instances versus negative and then positive instances in a mixed series. Furthermore, the experiments which have been conducted dealing with the use of positive and negative instances were not carried out in a classroom setting with the goal of actually transmitting as much information as possible to a group. Researchers have determined optimum conditions for concept learning with regard to variables such as task definition, nature of instances encountered, and feedback. The present study was an attempt to use these optimum conditions by incorporating them into a teaching plan for use in a regular classroom. The study was also an investigation into the effects produced on learning by varying sequences of positive and negative instances on conic sections with two classes of sophomore algebra students.

Importance of the Study

Concept learning is the foundation of all learning in our educational system. John P. DeCecco (1968) discusses the important role which concepts play in education by listing the following advantages which they offer:

1. Concepts simplify the individual's environment and help us to identify objects in the world around us by providing classes of objects to be learned. This frees us from the necessity of learning the individual attributes of every object we might encounter. Earl B. Hunt (1962) has pointed out that man is overwhelmed by shades of different attributes every day and gives as an example the fact that

there are over seven million discernable different colors. He comments:

> To categorize is to render discriminably different things equivalent, to group the objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness (p. 1).

DeCecco has called this categorizing activity " . . . the need for all of us to classify the confusion of our world and to render it more amenable to our control and satisfaction (p. 388)."

2. Concepts reduce the necessity of constant learning or recovering of material and thus enable students to acquire increasing amounts of knowledge as they progress through a structured subject such as mathematics. Bruner, Goodnow, & Austin (1956) speak of "conceptual innocence (p. 50)" in a discussion of how concepts provide a foundation for further learning, making the point that many important concepts are so basic that an individual cannot remember when he did not possess them.

3. Concepts give direction for correct courses of action, as in problem solving, providing for instrumental activity by pointing the way toward appropriate action to be taken.

4. Concepts make instruction easier by allowing teachers to use verbalization instead of actual experience to illustrate or explain new concepts and principles.

One of the greatest advantages which man holds over the lower animals is his ability to visualize the nonconcrete. Much of the progress man has made since primitive times can be traced to this ability to visualize in the absence of an existing model. Hunt (1962) has stated, "The ability to think in terms of abstractions is one of the most powerful tools man possesses (p. 1)."

The foregoing discussion, stressing the importance of concept formation to learning, supports the importance of finding more efficient techniques for teaching concepts. This study was an attempt to find which positioning of series containing all positive or all negative instances was more efficient in producing proper concept formation.

Limitations of the Study

This study was carried out under certain limiting conditions. Due to these limitations, generalizations should not be made on the basis of the findings of this study alone. These limiting conditions were as follows:

1. The study was carried out in the classroom as part of a regular teaching unit. This environmental limitation necessitated the inclusion of certain conditions which are not normally found in laboratory experimentation. Unavoidable verbal interaction about concept meaning between the subjects and between the subjects and the experimenter beyond what would be allowed in a strict experimental situation is an example of this.

2. Concepts which had greatly varying forms were used. In other experiments of this type, concepts used have had very obvious and

strictly defined attributes and values. The concept of a green triangle inside a black circle, an example of the type of concept commonly used in experimentation on concept learning, is much more strictly defined than, for example, the parabolic curve. In the latter concept, although form is the only relevant attribute, it may have innumerable values which are a function of the distance of its branches from each other, the location of its axis of symmetry, and the coordinates of its turning point.

3. Nonstandardized paper and pencil tests were used to ascertain the amount of concept learning which had occurred. Since no tests existed which measured the amount of concept learning on conic sections that had occurred due to the presentation of positive and negative instances, it was necessary to formulate such tests. Although great care was exercised to insure that all instances used on these tests were relevant to the series of instances which had been shown to the subjects earlier, there were three major flaws in them.

A. The tests, with the exception of Test 8, contained a relatively small number of items--seven on each test.

B. The items on each test probably did not differ enough from the positive and negative instances shown in the original series to allow for sufficient discrimination between subjects who remembered the instances from the original series and subjects who really understood the concept. This is especially true of the tests which measured the form of the graph for each conic section. Because of this, test results must be interpreted as containing the element of memorization as well as actual concept learning.

C. Each item required only that subjects label it as a positive instance or a negative instance. Such an "either or" item which allows only two choices, one of which the subject knows must be correct, also allows for the element of guessing the correct answer. No adjustment for such guessing was made in figuring test scores.

4. The size of each group was small enough to be a limiting factor in accepting test results as final.

Hypotheses

In order to study the effect on concept learning of presentation order of positive and negative instances the following null hypotheses were tested by statistical analysis of the data collected:

1. There is no significant difference in the concept learning related to the form of a parabolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

2. There is no significant difference in the concept learning related to the form of a quadratic equation producing a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and

subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

3. There is no significant difference in the concept learning related to the form of a quadratic equation producing a circular graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

4. There is no significant difference in the concept learning related to the form of an elliptical graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

5. There is no significant difference in the concept learning related to the form of a quadratic equation producing an elliptical graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

6. There is no significant difference in the concept learning related to the form of a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of

positive instances followed by a series of negative instances in the presence of a focus example.

7. There is no significant difference in the concept learning related to the form of a quadratic equation producing a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example.

8. There is no significant difference in the concept learning related to a mixed series of quadratic equations of subjects who have consistently received the seven basic area presentations consisting of a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects who have consistently received the seven basic area presentations consisting of a series of positive instances followed by a series of negative instances in the presence of a focus example.

9. There is no significant difference in the concept learning related to an entire unit on conic sections of subjects who have consistently received the seven basic area presentations consisting of a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects who have consistently received the seven basic area presentations consisting of a series of positive instances followed by a series of negative instances in the presence of a focus example.

Definition of Terms

Concept. A concept is a class of stimuli which has common characteristics. A particular stimulus by itself is not a concept, but the entire class of which it is a member is a concept. (De Cecco, 1968). The concept "dog" can be used as an example. A German shepherd, a chihuahua, and a poodle are examples of dogs. Although these animals are dissimilar in general appearance, even a small child could classify each as a dog. This is the concept--the class of stimuli having common characteristics such as four legs, hair, barking and tail wagging behavior--of which each species of dog is a member. None of the dogs is a concept by and of itself.

Attribute. Hunt (1962) defines an attribute as "any discernable and discriminating feature of an event that may vary from one concept to another (p. 26)." De Cecco (1968) defines an attribute as "a distinctive feature of a concept (p. 388)." Any characteristic such as color, form, or position may be an attribute. The presence of hair, four legs, two ears, and barking behavior may be considered attributes of the concept dog. The more complex the concept, the more attributes it has.

Attribute values. Values are the different ways in which an attribute may be expressed. For example, the concept of a red triangle has two attributes, color and form. The attribute of color has the value red; the attribute of form has the value triangle.

Conjunctive concept. A conjunctive concept is defined by the joint presence of the appropriate value of several attributes (Hunt, 1962). These appropriate values are added to produce a conjunctive concept. In the case of a red triangle, the concept is conjunctive. The concept must be red and have three straight connected sides.

Disjunctive concept. A disjunctive concept may have one or another of certain attributes. It is not additive as the conjunctive concept is; the presence of any one of the stated attributes is enough to qualify it as a certain concept. For example, if the concept to be considered were any figure which is red or triangular in shape then red circles and green triangles would both be members of the set of concepts. This is a disjunctive concept. Disjunctive concepts are, as a general rule, more difficult to learn than are conjunctive concepts.

Positive instance of a concept. A positive instance of a concept is any example or member of the class making up the concept which contains all the attributes necessary to define the concept.

Negative instance of a concept. A negative instance of a concept is any example which does not contain all the attributes necessary to define the concept. In the case of a conjunctive concept with several defining attributes, the absence of only one attribute would make an example a negative instance. This can, of course, range all the way down to an example having none of the necessary attributes for inclusion in a class. As the concept and the learner become increasingly attainment regardless of how many instances it takes to get there, and to minimize the number of wrong categorizations before attainment (Hunt, 1962, pp. 54-60).

Selection strategy. A selection strategy is a strategy that follows the following pattern: (1) The subject makes a guess about the concept and its attributes, (2) The subject tests his guess about the concept against the given examples and/or remembered examples previously shown him, and, (3) The subject revises or retains his original hypothesis according to the feedback he receives after making his guess (Kates and Yudin, 1964).

Conservative focusing. Conservative focusing is a type of selection strategy widely used when conjunctive concepts are under consideration. The subject finds a positive instance to use as a focus; then he makes a series of choices, altering only one attribute value each time. He tests his choices by using the feedback he receives to see if the change yields a positive or negative instance (Hunt, 1962).

Focus gambling. Focus gambling is a strategy used when time is a determining factor. In focus gambling, the subject follows the same pattern as in conservative focusing, but may change more than one attribute at a time. This pays off well if the change results in a positive example, but it involves more risk than conservative focusing. If the change results in a negative example the subject must go back to his original example and start all over again since he does attainment regardless of how many instances it takes to get there, and to minimize the number of wrong categorizations before attainment (Hunt, 1962, pp. 54-60).

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Concept attainment. Concept attainment refers to "the process of finding predictive defining attributes that distinguish exemplars from nonexemplars of the class one seeks to discriminate (Hunt, 1962, p. 22)." It is not necessary that the subject verbalize attributes if he can choose correctly whether an instance is positive or negative.

Source of the Data

The data used in this study for equalization of the two groups of subjects were obtained from students' cumulative folders. The data used to determine the concept attainment of the two groups were obtained from scores on nine paper and pencil tests administered after the presentation of each series.

Organization of the Study

Statistical analysis of the data collected is presented in the form of tables for clarity. Chapter I discusses the problem of the study. Chapter II is a review of related research and current literature dealing with the effect of presentation order of positive and negative instances on concept learning. Chapter III presents and interprets the data collected. Chapter IV summarizes the findings of the study and presents conclusions which can be drawn from the study and recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

The literature of concept learning is conflicting and confusing in results obtained from various studies. Many seemingly exact investigations have produced dissimilar results and conclusions. The reason for this state of affairs is the presence of many intervening variables which have a great influence on how and under what conditions concept learning best takes place. The major cause for discrepancies in results from one study to another has been a lack of sufficient control over these influencing variables.

Bruner et al. (1956) have done one of the most exhaustive studies of concept formation and its relationship to learning and thinking. In their book, A Study of Thinking, they cite the following variables which influence concept learning: (1) How the task is defined, (2) The nature of instances encountered, (3) Presentation order, (4) The nature of validation, (5) The consequences of specific categorizations, and (6) Nature of imposed restrictions. The following discussion of the meaning of these variables and what their influence is is presented so that the findings from studies on concept learning may be fully appreciated.

1. How the task is defined. Is the person actually seeking to attain the concept; is he set to find the properties that categorize instances in a class or is he trying to memorize by rote memory each

instance's category? One of Bruner's studies showed that if the subject is looking for the basis of grouping, greater attainment was achieved.

2. Nature of instances encountered. This concerns the nature of the attributes exhibited by the instances, whether they are relavant or irrelevant and obvious or nonobvious. Bruner's studies showed that instances with clearly defined relevant attributes were more easily assimilated in a usable form than those with many irrelevant or nonobvious attributes. It was also found that the more attributes necessary for formation of a concept, the more hypotheses there were that could be formulated, usually leading to use of a quick elimination strategy by the subject.

3. Presentation order. Much research has been done on this particular aspect of concept learning. Bruner found that the subject needs a chance to sample attributes systematically and see their relationship to the concept under consideration. By reducing cognitive strain, orderly presentation reduced solution time and brought about new methods of attack.

4. Nature of validation. This variable has to do with feedback; does the subject learn after he identifies an instance as positive or negative if it is right, or does he find this out only after a series of encounters? Bruner found that immediate feedback after each identification produced the quickest learning.

5. Consequences of specific categorizations. This has to do with the price of wrong categorizing or the gain from correct categorizing with regard to the amount of usable information obtained. This has a direct influence on the strategies that subjects use, which in turn influences the type of instances that will produce the best results under given conditions.

6. Nature of imposed restrictions. Is there pressure of time and a need for speedy decisions? Such restrictions result in a different strategy also, usually focus gambling.

Smoke (1933) did the first published work on positive and negative instances and their influence on concept learning to receive wide attention. Using the concept MIB (a triangle with a line extending from the longest side of the triangle), he compared the performance of subjects who worked with a series of instances composed of half positive and half negative instances with that of a group working with only positive instances. He found no difference in solution time or attainment between the two groups. However, he did find that most students in the experiments preferred having the mixed series to the all positive series. Smoke suggested that subjects do not learn from examples of what a concept is not. He believed that negative examples in a mixed series were of benefit, however, since they discouraged snap judgments and prevented the subjects from reaching erroneous conclusions. Smoke's study has since been widely criticized on the grounds that he did not properly equate the two series for the amount of information that they contained. One, both, or neither of the series may have defined the concept without regard to strategies involved (Bruner et al., 1956; DeCecco, 1968; Hovland and Weiss, 1953; Hunt, 1962; Huttenlocher, 1962).

Olson (1963) replicated Smoke's study using materials from physics on reciprocal motion and levers. Although his findings confirmed Smoke's, he also failed to control for information content.

Huttenlocher (1962) partially replicated Smoke's experiment, correcting for equal amounts of information in each series, regardless of which type of instances were used. She allowed students to learn a conjunctive concept with a series of entirely positive series, entirely negative series, or a mixed series equated for information. No focus example was used with any of the series. Huttenlocher found that the mixed series group had the most success in attaining the concept, followed by the positive series. The group which had only the series of negative instances did the poorest. In addition, as an auxiliary finding which was most pertinent to the present study, she found that a series of positive examples following a series of negative examples facilitated concept learning in the mixed series.

An earlier attempt to correct the inadequacies of Smoke's study was done by Hovland and Weiss (1953). Although they did not follow Smoke's experiment as closely as did Huttenlocher, their study is notable for the careful control it exercised over the intervening variables discussed earlier. Instead of using a positive series and a mixed series, they chose to use one series comprised entirely of positive examples and one series comprised entirely of negative examples. They used no focus example and controlled for the amount of information in each series. They found that the positive series was highly superior to the negative series in facilitating concept attainment. This difference appeared regardless of whether simultaneous presentation (exposing all instances and letting them remain in view) or successive presentation (exposing each in turn and removing it after an interval before the next instance was exposed) was used.

Hovland and Weiss (1953) also postulated in their study that subjects would perform better on a series of one positive instance followed by two negative instances than on a series of the same two negative instances followed by a positive instance. They hypothesized that although the amount of information conveyed by the two series was the same, the two sets would have different degrees of effectiveness from the standpoint of assimilation of information by the subject. They stated:

> One reason for hypothesizing a difference is that in a mixed positive and negative series the effect of positive instances is to greatly reduce the number of hypotheses which must be considered, while negative instances specify which of the alternatives can be discarded. If the positives come first, S would only have to keep in mind a limited number of possibilities; whereas, when the negatives come first, only a few possible hypotheses are eliminated and therefore S must retain quite a few alternatives until the positive instances finally defines the correct choice. Thus it might be expected that the former arrangement would be superior to the latter in ease of concept attainment (p. 176).

However, Hovland and Weiss found that there was no difference in difficulty between the two series. In a mixed series, order apparently did not affect learning efficiency.

Hovland and Weiss (1953) also controlled for types of strategies used by running the experiment both with a conjunctive concept and a disjunctive concept. Similar results were obtained regardless of the type of concept used. This indicated that the original results indicating superiority of the positive series over the negative series was not due to biasing on the basis of strategies used by the subjects.

In the case of the disconjunctive concept, the experiment was set up so that the negative series should actually have facilitated the solution of the concept. Although the subjects were told that the concept was disjunctive, the expected gains from the use of the negative series under these conditions did not materialize. The positive series still produced the best results. Bruner et al. (1956) have suggested that negative instances provide information which must be transformed if the subject is to use the instances to test an hypothesis about a concept. An instance that illustrates the negative case (what a concept is not) requires that subjects use the "is not" case to infer what the concept is. This theory perhaps provides a partial explanation for the results obtained from the Hovland and Weiss study.

Braley (1963) extended the idea on negative concepts advanced by Bruner et al. and compared teaching a simple concept using all negative instances to teaching a difficult concept using all positive instances. Braley came to the conclusion that "exclusion strategies" must be used if only negative instances are given. In the exclusion strategy, the learner must remember all the attributes he has seen in the negative instances and eliminate the irrelevant attributes as he progresses toward solution of the problem. Only three of Braley's seventy subjects actually used this type of strategy to solve the problem when they were given the negative series. Braley concluded, "In the type of problem solving behavior investigated here the evidence is substantial of a gross inability to handle negative information (p. 159)."

Kurtz and Hovland (1956) showed that learning conjunctive concepts is easier if all the positive instances are presented in a block rather than having the positive and negative instances interspersed. They did not, however, indicate in what order the instances should be given for maximum learning using a mixed series--whether positive first and then negative or vice versa. They did conclude that ordered presentation of instances was to be highly favored over random presentation, since this type of presentation favors a focusing strategy and reduces strain on the memory.

Cahill and Hovland (1960) used all negative instances in an experiment designed primarily to test which type of presentation order was most advantageous for learning. Using no focus example and all negative instances, they used simultaneous successive presentation with one group (instances presented one at a time and left in view) and successive presentation with the other group. They found that the simultaneous successive method was superior to the successive presentation if enough negative instances were provided to rule out all possibilities other than the real one. This experiment, designed to explore the role memory plays in concept learning, showed that it is possible for learners to utilize negative examples if enough instances are provided. However, Hovland and Weiss (1953) had earlier proven that it was possible for subjects to use negative instances in concept learning if they were told what attributes were relevant. They also commented that in the case of two-dimensional concepts the minimum instances needed by the subject to identify the concept was two positive instances or ten negative instances. The use of negative instances alone is therefore relatively inefficient when compared with the efficiency of positive instances.

Yudin and Kates (1963) partially replicated Cahill and Hovland's experiment, but they eliminated the element of memory by providing a focus example with their series. In the first part of the experiment, they provided three conditions for learning the same concept to three different groups. One group received all simultaneous successive presentation with no focus, one group received all successive presentation with no focus, and the third group received all successive presentation with a focus example. They found that simultaneous successive presentation produced the best results, successive series produced the poorest results, and that the presence of the focus example used with the successive series produced intermediate results. In the second part of the experiment, two groups were used in an attempt to find out if negative and positive instances were equally effective in transmitting information. Successive presentation was used with both groups. One group was presented all negative instances with a focus example and the other group was presented all positive instances with a focus example. Yudin and Kates found no significant difference in strategies chosen or in perceptual errors. They concluded that negative examples help only when a positive instance or focus example accompanies them. A later study (Kates and Yudin, 1964) confirmed these earlier findings.

The literature seems to support the viewpoint that negative instances alone do not present information in a form that is amenable to rapid concept formation. Findings which show no difference between positive instances and negative instances with regard to the amount of information they transmit come from studies where the negative instances were accompanied by positive instances or a focus example.

Hunt (1962) suggests strongly that negative instances serve only as a contrast class by which attributes may be defined. If this is the case, it would seem that the order in which positive and negative instances were presented would have no effect upon concept attainment under ideal conditions such as presence of a focus example, successive simultaneous presentation, immediate feedback of results, and the use of both positive and negative instances. The present study was an attempt to see if a difference did exist in concept attainment when these ideal conditions were used in a regular classroom situation and presentation order of positive and negative instances was varied.

CHAPTER III

PRESENTATION AND INTERPRETATION OF DATA

Subjects

Fifty-one sophomores enrolled in two sections of second year algebra were the subjects for this study. The students had been randomly scheduled into two classes. One section contained twenty-five members and the other contained twenty-six members. Prior to the experiment the two groups were equated statistically in three areas: IQ scores derived from the California Achievement Test, arithmetic achievement subscores on the California Achievement Test, and scores attained on a teacher-constructed test of necessary entering behavior for a unit on conic sections. No significant difference was found between the two groups on any of these scores, as is shown in Table I.

TABLE I

Comparison of Mean Scores Equalizing Groups I and II

	Group I		Group II		
Test	Mean Score	SD	Mean Score	SD	t
IQ	106.86	11.92	107.23	10.58	.1150
Arithmetic Achievement	9.244	.570	8.75	1.09	1.9066
Entering Behavior	30.28	3.62	31.54	3.72	.0953

Procedure

The S's task was to derive the combination of attributes defining a concept on the basis of stimulus figures which either included all the attributes of the concept (positive instances) or lacked one of the necessary attributes (negative instances). Seven series of problems were presented, as shown in Table II.

TABLE II

Series Types Presented to Groups I and II

Test	Problem Series	Number of Attributes	Type of Concept
1	Parabola (form of graph)	1	Conjunctive
2	Parabola (form of equation)	2	Conjunctive
3	Circle (form of equation)	3	Conjunctive
4	Ellipse (form of graph)	1	Conjunctive
5	Ellipse (form of equation)	3	Conjunctive
6	Hyperbola (form of graph)	1	Conjunctive
7	Hyperbola (form of equation)	3	Disjunctive

Each day the groups were exposed to one type of problem series; the following day each group was given the same test measuring how well the concept had been attained. Each test covering the seven series required that Ss pick out positive examples of the concept from a mixed series of seven examples. Test 8 involved a mixed series of twenty equations which were all positive examples of the four conic sections presented. S's task was to identify what conic section each equation represented. The final test covered the entire unit of work and included graphing the conic sections and defining them as a locus of points and as sections through a solid cone in addition to identifying positive examples of form and equation for each.

The pretest-posttest control group experimental design was used. The overhead projector was used to show the series to the groups. By using the overhead projector, the presentation order, time of exposure, and amount of information to be disclosed to the group could easily be controlled.

Group I, the experimental group, was shown a focus example of the concept followed by a series of five negative examples using simultaneous successive presentation (uncovering each instance in succession and leaving each exposed instance in view during the remainder of the presentation). These figures were left in view and followed by a series of five positive examples of the concept using simultaneous successive presentation.

Group II, the control group, was treated in exactly the same way except the presentation order of the positive and negative series was reversed. In Group II the focus example was shown, the positive series was shown, and then the negative series was shown.

Each group was told whether the series being shown was positive or negative. Approximately fifteen seconds were allowed to elapse between the showing of each example and the next one. The class members were not allowed to comment or ask questions during the presentation of the series of positive and negative instances. After the presentation was completed, class members were allowed time for questions and discussion of attributes.

Positive examples illustrated all relevant attributes of the concept under consideration and also illustrated cases in which certain attributes were not relevant. Each negative example violated only one attribute of the concept. DeCecco (1968) suggests that in a teaching situation negative instances which contain attributes usually confusing to students should be used. This was done as much as possible in formulating the instances presented in the negative series.

The procedure used followed an outline for such experiments suggested by Bruner et al. (1956) in which the following items were presented:

1. Enough instances to allow sufficient information for concept attainment should be used, but no instances should be redundant.

2. Positive and negative instances should be in a one-to-one ratio.

3. The total number of instances presented for each topic should be the same.

Results

The mean scores and standard deviation for each group on each of the nine tests is presented in Table III. The standard error of the difference between the means was figured using the formula for unequal groups. The t-test was used to determine significance. The value of t for significance at the .05 level is 2.008.

Hypothesis 1 was stated as follows: There is no significant difference in the concept learning related to the form of a parabolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of a parabolic graph Group I had a mean score of 6.88 and a standard deviation of .325. Group II had a mean score of 6.62 and a standard deviation of .502. The value of t was 1.9808. Since this is not significant at the .05 level, null hypothesis 1 was accepted.

Hypothesis 2 was stated as follows: There is no significant difference in the concept learning related to the form of a quadratic equation producing a parabolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the

TABLE III

Comparison of Mean Scores for Groups I and II

	GROUP I		GROUP II		
Test	Mean Score	SD	Mean Score	SD	t
1	6.88	.325	6.62	.502	1.9808
2	6.92	.170	6.95	.340	.1184
3	6.76	1.021	6.92	.337	.7593
4	6.82	.476	6.89	.167	.7078
5	6.35	2.250	6.04	1.100	.6676
6	6.76	.585	6.35	.750	2.0993*
7	6.48	.806	6.65	.860	.7143
8	17.92	2.512	16.27	3.543	1.8730
Final Unit Test	81.28	14.87	77.31	16.650	.8862

*Significant at .05 level with 49 df

form of a quadratic equation producing a parabolic graph Group I had a mean score of 6.92 and a standard deviation of .170. Group II had a mean score of 6.95 and a standard deviation of .340. The value of t was .1184. Since this is not significant at the .05 level, null hypothesis 2 was accepted.

Hypothesis 3 was stated as follows: There is no significant difference in the concept learning related to the form of a quadratic equation producing a circular graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of a quadratic equation producing a circular graph, Group I had a mean score of 6.76 and a standard deviation of 1.021. Group II had a mean score of 6.92 and a standard deviation of .337. The value of t was .7593. Since this is not significant at the .05 level, null hypothesis 3 was accepted.

Hypothesis 4 was stated as follows: There is no significant difference in the concept learning related to the form of an elliptical graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of an elliptical graph, Group I had a mean score of 6.82 and a standard deviation of .476. Group II had a mean score of 6.89 and a standard deviation of .167. The value of t was .7078. Since this is not significant at the .05 level, null hypothesis 4 was accepted.

Hypothesis 5 was stated as follows: There is no significant difference in the concept learning related to the form of a quadratic equation producing an elliptical graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of a quadratic equation producing an elliptical graph, Group I had a mean score of 6.35 and a standard deviation of 2.250. Group II had a mean score of 6.04 and a standard deviation of 1.100. The value of t was .6676. Since this is not significant at the .05 level, null hypothesis 5 was accepted.

Hypothesis 6 was stated as follows: There is no significant difference in the concept learning related to the form of a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of a hyperbolic graph, Group I had a mean score of 6.76 and a standard deviation of .585.

Group II had a mean score of 6.35 and a standard deviation of .750. The value of t was 2.0993. Since this is significant at the .05 level, null hypothesis 6 was rejected.

Hypothesis 7 was stated as follows: There is no significant difference in the concept learning related to the form of a quadratic equation producing a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects receiving a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment of the form of a quadratic equation producing a hyperbolic graph, Group I had a mean score of 6.48 and a standard deviation of .806. Group II had a mean score of 6.65 and a standard deviation of .860. The value of t was .7143. Since this is not significant at the .05 level, null hypothesis 7 was accepted.

Hypothesis 8 was stated as follows: There is no significant difference in the concept learning related to a mixed series of quadratic equations of subjects who have consistently received the seven basic area presentations consisting of a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects who have consistently received the seven basic area presentations consisting of a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment related to a mixed series of quadratic equations, Group I had a mean score of 17.92 and a standard deviation of 2.512. Group II had a mean score of 16.27 and a standard deviation of 3.543. The value of t was 1.8730. Since this is not significant at the .05 level, null hypothesis 8 was accepted.

Hypothesis 9 was stated as follows: There is no significant difference in the concept learning related to an entire unit on conic sections of subjects who have consistently received the seven basic area presentations consisting of a series of negative instances followed by a series of positive instances in the presence of a focus example and subjects who have consistently received the seven basic area presentations consisting of a series of positive instances followed by a series of negative instances in the presence of a focus example. On the test for concept attainment related to an entire unit on conic sections, Group I had a mean score of 81.28 and a standard deviation of 14.87. Group II had a mean score of 77.31 and a standard deviation of 16.65. The value of t was .8862. Since this is not significant at the .05 level, null hypothesis 9 was accepted.

Briefly summarizing these results, no significant difference between the means of the two groups was found for any test except Test 6. This difference was in favor of Group I which had received the negative series first. The results of this study indicate that when a focus example is used the efficiency of negative series followed by positive series is no greater than that of a positive series followed by a negative series.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

Summary

This research project was concerned with the efficiency of presentation order of positive and negative instances as related to learning certain mathematical concepts expressed by the four conic sections. It dealt with two types of mathematical concepts--the form of a graph and the form of an equation. Each of these concepts was taught in relation to the parabola, the circle, the ellipse, and the hyperbola.

Two classes of sophomore students enrolled in second year algebra at Todd County Central High School were used as subjects for the study. Group I received a series of negative instances followed by a series of positive instances for each concept taught. Group II received the same instances but in reverse order. Data collected to test for significance of the difference between the means was in the form of scores on paper and pencil tests administered by the instructor. These tests had been designed to test concept attainment in each of the seven basic areas. In addition, two tests covering larger units of concept learning related to the entire teaching unit were administered.

Statistical analysis by use of the t-test revealed no significant difference in concept attainment between the two groups on eight of the nine tests administered. The value of t on Test 6 was significant at the .05 level. This led to the rejection of the null hypothesis that stated there is no significant difference in the concept learning related to the form of a hyperbolic graph of subjects receiving a series of negative instances followed by a series of positive instances and subjects receiving a series of positive instances followed by a series of negative instances.

Conclusions

Much of the preceding discussion of the literature suggested reasons why the two groups in the present study showed no difference in concept attainment. The use of a focus example negated any adverse effect the negative series might have had due to position (Yudin and Kates, 1963; Kates and Yudin, 1964). Hovland and Weiss (1953) have confirmed that the absence of a focus example makes a positive series highly superior to a negative series in facilitating concept attainment if each group is shown either all one series or the other. They further showed that in a mixed series the positioning of positive and negative instances produced no effect on learning efficiency. However, Kurtz and Hovland (1956) later showed that ordered presentation was much more efficient than random presentation. Feedback was shown to be an important factor in concept attainment when both positive and negative instances were used (Bruner et al., 1956). Simultaneous successive presentation was shown to be superior to successive presentation (Yudin and Kates, 1963).

This study was an attempt to provide constant favorable conditions for each group using those variables which had been previously shown to be of optimum value. These variables were use of a focus example, ordered presentation of the series, simultaneous successive presentation, and immediate feedback.

The general null hypothesis that under such conditions no difference between the groups would be found was supported by the findings in all but one series. On the weight of these findings, it would seem that when a focus example is used the efficiency of negative series followed by positive series is no greater than that of a positive series followed by a negative series.

No explanation has been found to show why a significant difference between the means appeared in concept learning related to the form of the graph of a hyperbola. Test 6 covered a concept which was of the same general nature as the concepts covered by Test 1 and Test 4. The latter tests showed no significant difference between the mean scores for the two groups. All three concepts on these three tests were conjunctive and each contained only one relevant attribute. In each case this attribute was the shape of the curve.

An analysis of the individual tests showed that on Test 6 Ss in Group II most often identified two particular shapes as being positive instances when they were in fact negative instances. These two examples could not have been mistakenly identified due to perceptual errors since both were very plainly negative instances. Test 6, page

59, will illustrate this point. Example 7 could have been mistaken for a negative instance by some students due to perceptual errors if they saw the branch of the hyperbola in the second quadrant as touching the x-axis. This was not a common error on this test. However, the two examples previously mentioned which were the greatest source of errors in Group II were examples 2 and 6. In example 2 the branches of the curves are not symmetrical and in example 6 they are in adjacent quadrants. Both of these are very plainly in violation of the form a hyperbolic curve takes and similar examples were included in the original series, as shown on page 52. Moreover, these two examples were not common sources of errors in Group I.

Although the findings showed that neither form of presentation order was superior to the other with regard to scores on paper and pencil tests, the subjective observation of the investigator did indicate a superiority of one over the other with regard to motivating the students and holding their attention. The presentation showing the negative series first and then the positive series was definitely superior in this respect.

Group I, which received the negative series first and then the positive series, appeared to be much more involved and alert during the series presentation than did Group II. Students in Group I immediately began to compare the negative instances with the focus example in an attempt to discover missing or distorted attributes. This immediate involvement carried over into the presentation of the positive series as well.

Students in Group II were observed to take an accepting, nonchalant attitude during the first part of the presentation when positive examples were presented first. They did not become intensely involved as indicated by their sitting position (leaning forward in seat rather than slumping back) and eye movements (concentrated on examples rather than looking elsewhere in the room) until the negative series was presented. Then they also reacted as Group I had done during the entire presentation.

From the standpoint of student involvement in presentation of instances designed to facilitate concept attainment, a presentation order which positions the negative series first and then the positive series seems to be superior when a focus example is used. It should be reiterated, however, that this conclusion comes from observation only and is not supported by statistical data derived from empirical measures of student involvement or motivation.

Environmental Limitations

There are several limitations in the present study in addition to those cited in Chapter I which should be considered in drawing conclusions from the data. All of these limitations are directly related to the fact that this study was conducted in a classroom environment in the course of a regular teaching unit. These limitations tended to negate any effect that presentation order might have had.

1. Ss were told what the concept was after presentation of the examples. Because of this, concept formation did not assume the

character of a guessing game as it does in many studies of this kind. In the majority of studies on concept formation it is the task of the S alone to define the concept.

2. After presentation of the two series each group was allowed to ask questions and have discussion on relevant and irrelevant attributes of the concept being considered.

3. The time lapse between showing the series and testing for concept attainment allowed for additional learning on the concept.

Since the Ss had additional opportunities to get information from other classroom activities, the results of the tests are not entirely due to the showing of positive and negative instances. Other concomitant learning took place during the time lapse. This time lapse also had the effect of allowing many intervening variables to become affective on the final results for each test.

Recommendations for Further Study

1. It is recommended that further research be done on the effect of presentation order of positive and negative instances on concept learning when the time lapse between showing the instances and testing for concept attainment is short enough to control for concomitant learning.

2. It is recommended that further research be done on the effect of presentation order of positive and negative instances on concept learning in classroom situations using subject areas other than

mathematics. English grammar would be one such area in which this could be carried out.

3. It is recommended that further research be done on the effect of presentation order of positive and negative instances on concept learning using larger groups of subjects than were used in the present study.

4. It is recommended that further research be done on the effect of presentation order of positive and negative instances on concept learning using concepts that contain more attributes and are therefore more complex than the concepts used in the present study.

5. It is recommended that further research be done on the effect on presentation order of positive and negative instances on concept learning comparing the efficiency of each type of presentation as related to very simple concepts having only one clearly defined attribute versus difficult concepts having many obscure attributes.

6. It is recommended that further research be done on the effect of presentation order of positive and negative instances on concept learning by using a third group in which no instances are presented or in which instances are presented in mixed order.

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APPENDIX

TEST OF ENTERING BEHAVIOR

1. a. Given the equation $4x + 2y = 6$, write 3 pairs of number values (x,y) which satisfy the equation.

   b. Plot the 3 pairs of number values obtained in part a on a set of coordinate axes.

2. a. Pick out the number(s) of the figures from the group on the board which are ovals. Write the numbers in this space.

   ____

   b. Pick out the number(s) of the figures from the group on the board which are circles. Write the numbers in this space.

   ____

   c. Pick out the number(s) of the figures from the group on the board which are closed curves. Write the numbers in this space. ____________________

   d. Pick out the number(s) of the figures from the group on the board which are open curves. Write the numbers in this space.

   ____

3. Given the equation $x^2 + 2x - 6 = y$ tell which of the following points would be on the graph of this equation and prove your answer for each. Do not graph the line.

   a. (1, -3) Yes, No (Circle one)

   Proof:

   b. (0, 6) Yes, No (Circle one)

   Proof:

   c. (1/2, -4 3/4) Yes, No (Circle one)

   Proof:

4. Factor:

a. $4x^2 - 4y^2$

b. $9x^2 - 16y^2$

5. Given: $3x + 4y = 12$

a. Write the x-intercept of the line

b. Write the y-intercept of the line

c. Use the values obtained in parts a and b to graph the given equation below.

6. Given: $25x^2 + 36y^2 = 900$. Rewrite the given equation in the space below so that the right-hand member is equal to 1. Do not rearrange the equation.

7. Factor the following:

a. $x^2 - y^2$

b. $x^2 + 2x + 3$

c. $x^3 + y^3$

d. $x^2 + 5x + 6$

e. $x^2 + 4x + 4$

f. $x(a+b) + y(a+b)$

g. $3x + 6y + 6x^2 + 12xy$

h. $(x + y)^2 - z^2$

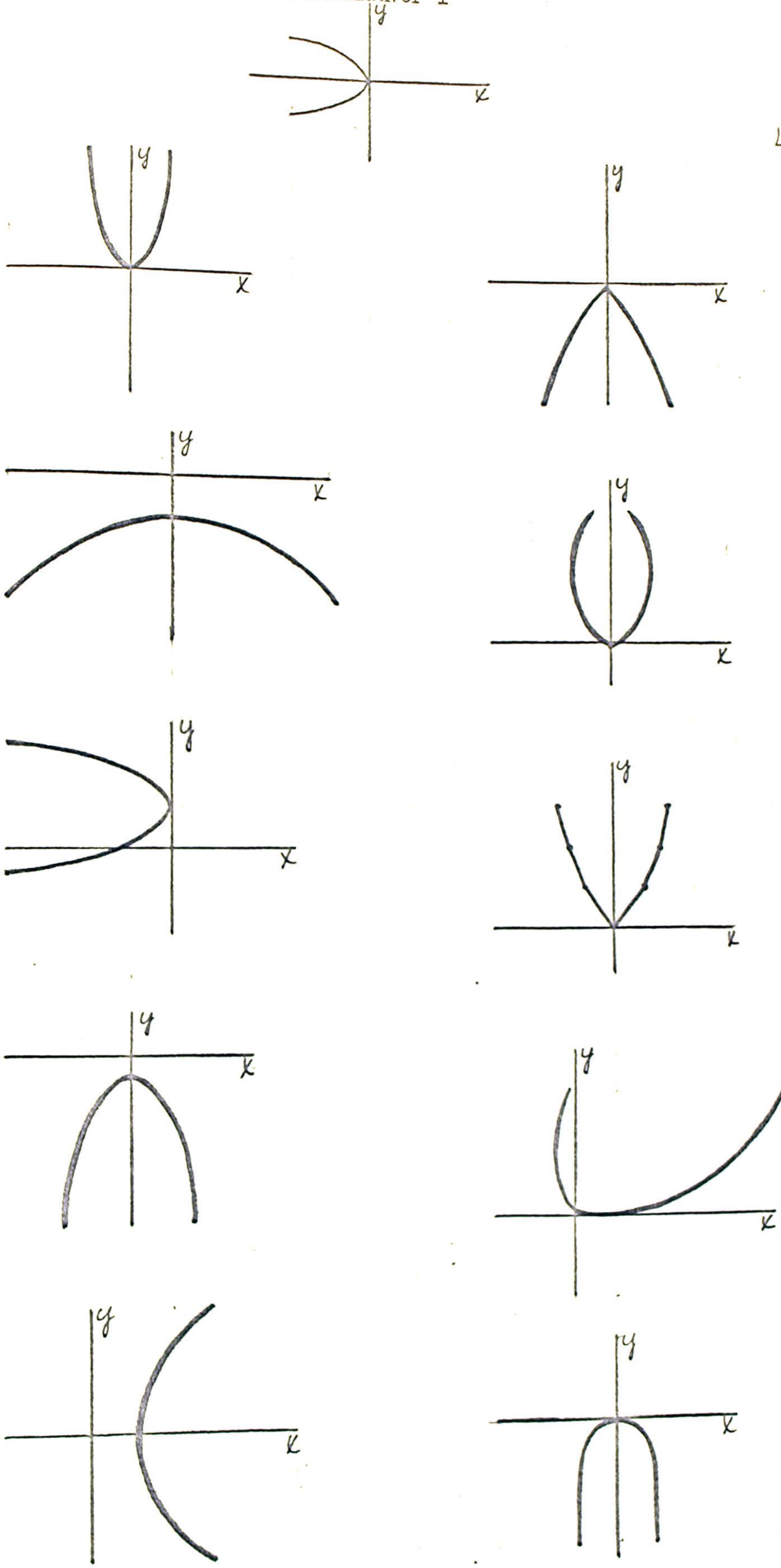
8. If $y = x^2 + 3x - 5$ find y when

a. $x = 3$

b. $x = -4$

c. $x = 2/3$

SERIES TRANSPARENCY 1



SERIES TRANSPARENCY 2

PARABOLA

$y = ax^2 + bx + c$ or $x = ay^2 + by + c$; b or c may equal 0

$x^2 + y = 10$

$x = y^2 + 2y - 5$

$y^2 + x = 20$

$y = 2x^2 - 3x + 8$

$y^2 - 6y - 12x - 15 = 0$

$x^2 + 2x + 1 = y^2$

$x^2y = 20$

$x^2 + y^2 = 20$

$y^2 - x^2 = 4$

$x = y + 2$

SERIES TRANSPARENCY 3

CIRCLE

$$Ax^2 + Ay^2 = r^2$$

$x^2 + y^2 = 100$

$25x^2 + 25y^2 = 0$

$10y^2 + 10x^2 = 250$

$(x+1)^2 + (y-3)^2 = 17$

$x^2 + y^2 = 50$

$x^2 - y^2 = 100$

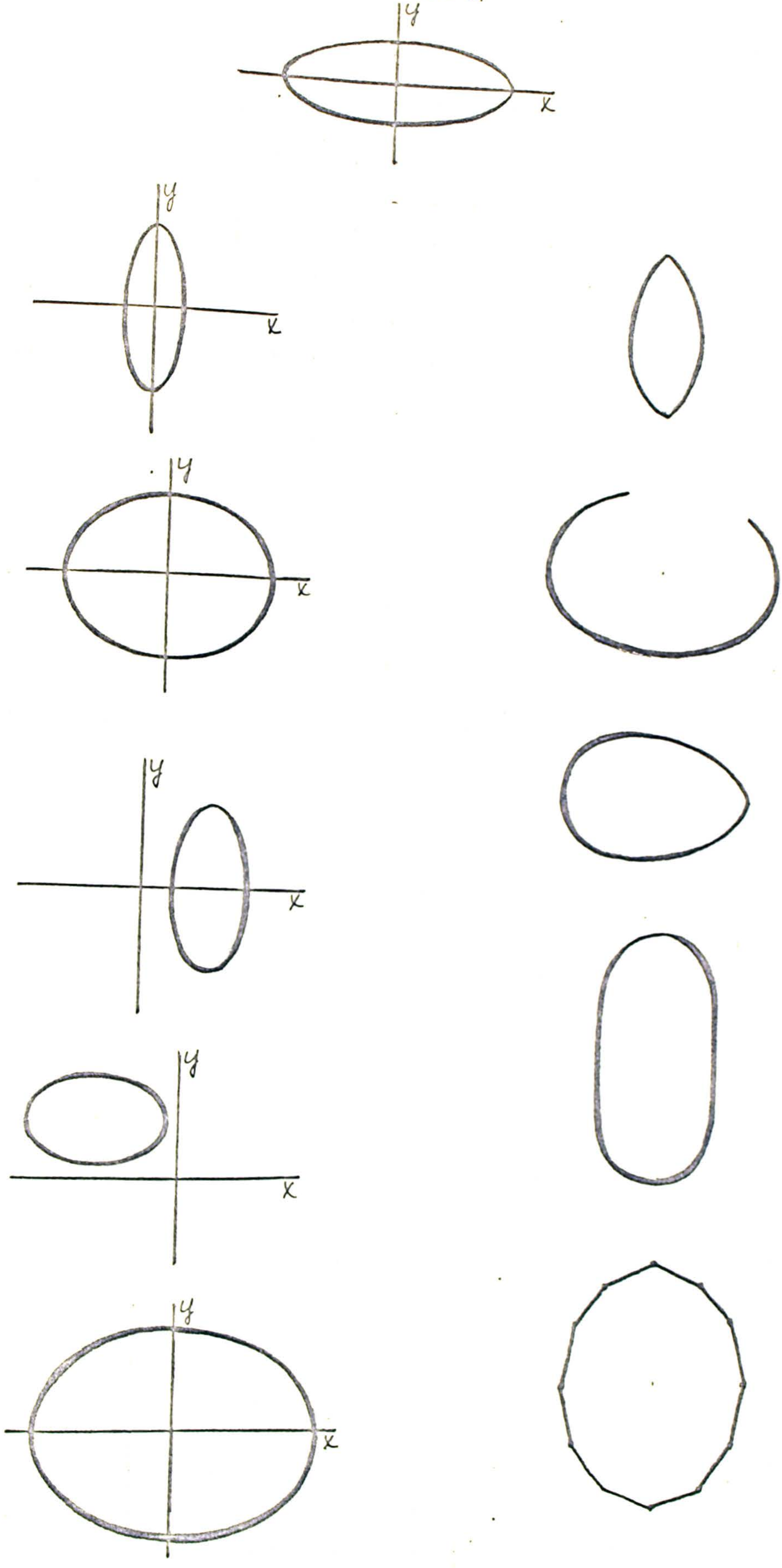
$9x^2 + 25y^2 = 1$

$x^2 + 6y^2 = 100$

$5x^2 - 5y^2 = 500$

$100 + y^2 = x^2$

SERIES TRANSPARENCY 4



SERIES TRANSPARENCY 5

ELLIPSE

$Ax^2 + By^2 = C$ or $x^2/B + y^2/A = 1$ where $A \neq B$

$9x^2 + 16y^2 = 576$

$x^2/9 + y^2/16 = 1$

$x^2 + 9y^2 = 36$

$25y^2 + 16x^2 = 400$

$(x-5)^2/100 + (y+2)^2/9 = 1$

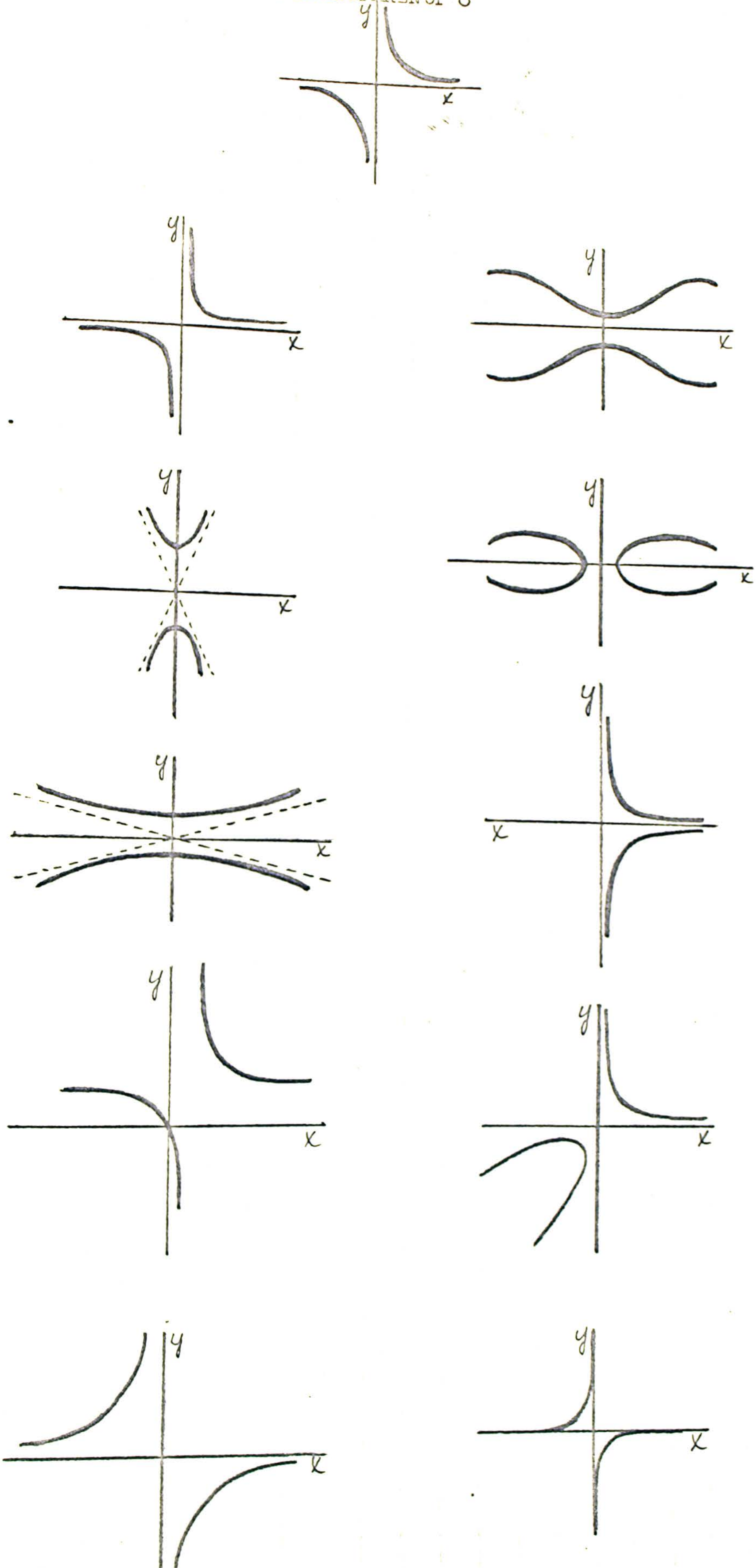
$9x^2 - 16y^2 = 144$

$25x^2 + 25y^2 = 100$

$x^2 - y^2 = 100$

$(x+3)^2 + (y-1)^2 = 25$

$x^2/6 - y^2/10 = 1$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SERIES TRANSPARENCY 7

HYPERBOLA

$$Ax^2 - By^2 = C \quad \text{or} \quad xy = K$$

$x^2 - y^2 = 25$

$xy = 6$

$4y^2 - 25x^2 = 100$

$5xy - 10 = 0$

$3x^2 = 27 + 3y^2$

$x^2 + y^2 = 100$

$3x^2 + 6y^2 = 18$

$x - y = 6$

$x^2y = 10$

$x^2 - y = 100$

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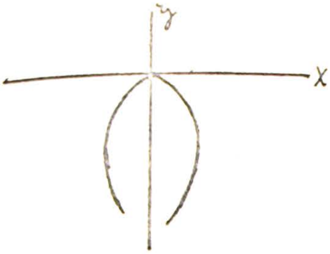

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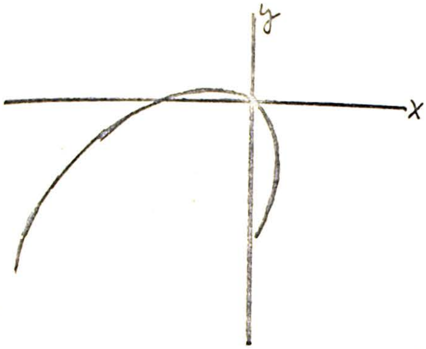

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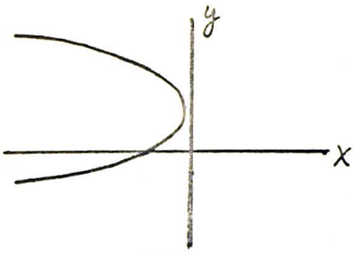

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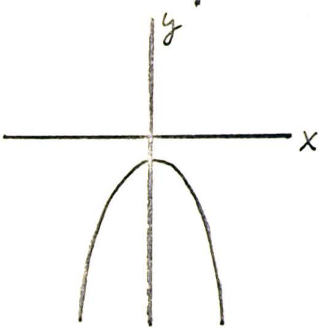

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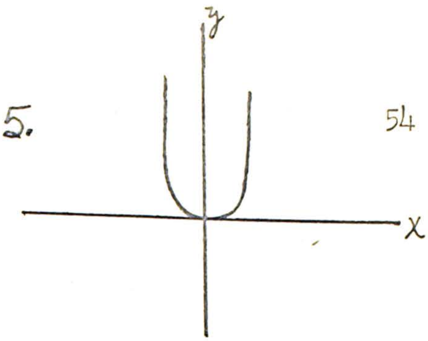

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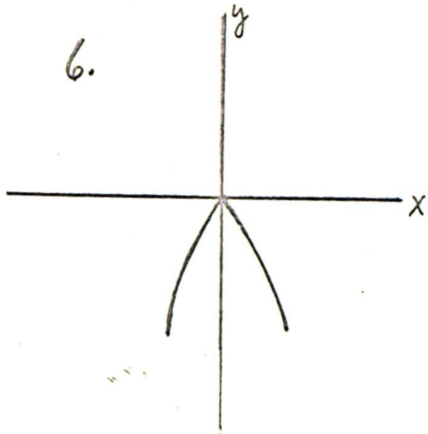

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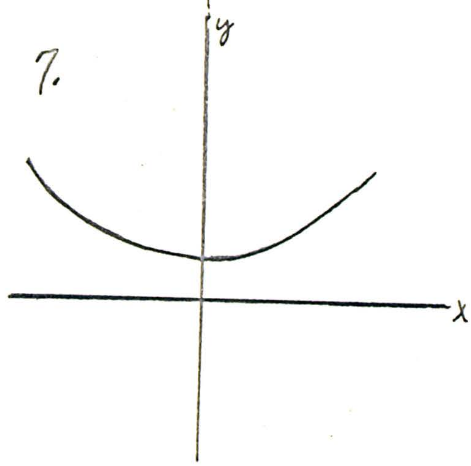

TEST 2

DIRECTIONS: SOME OF THE FOLLOWING EQUATIONS ARE SATISFIED BY SETS OF ORDERED PAIRS WHICH FORM THE LOCUS OF POINTS BELONGING TO A PARABOLA. CIRCLE THE NUMBER IN FRONT OF EACH SUCH EQUATION. THOSE THAT DO NOT BELONG TO THE SET OF EQUATIONS WHICH WILL FORM A PARABOLA WHEN GRAPHED ARE TO BE LEFT BLANK.

1. $x^2y = 10$

2. $y^2 + x^2 = 4$

3. $xy = 10$

4. $x = 2y^2 + 6y - 1$

5. $y = 3x^2 + 3$

6. $3y^2 = 2x^2 - 6$

7. $x + y^2 = 6$

TEST 3

DIRECTIONS: SOME OF THE FOLLOWING EQUATIONS ARE SATISFIED BY SETS OF
ORDERED PAIRS WHICH FORM THE LOCUS OF POINTS BELONGING TO 56
A CIRCLE. CIRCLE THE NUMBER IN FRONT OF EACH SUCH
EQUATION. THOSE THAT DO NOT BELONG TO THE SET OF EQUATIONS
WHICH WILL MAKE A CIRCLE WHEN GRAPHED ARE TO BE LEFT BLANK.

1. $x^2 + y^2 = 36$

2. $x^2 - y^2 = 25$

3. $3x^2 + 4y^2 = 1$

4. $(x - 2)^2 + (y + 5)^2 = 100$

5. $x^2 + 25y^2 = 100$

6. $x^2 + y^2 = 15$

7. $4x^2 + 4y^2 = 9$

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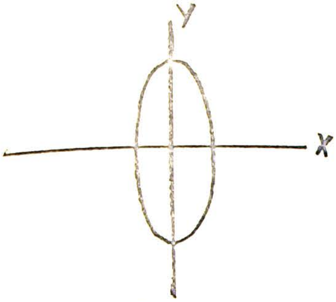

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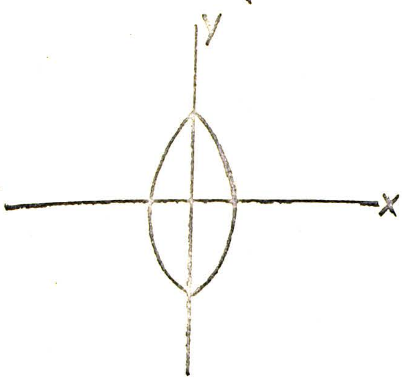

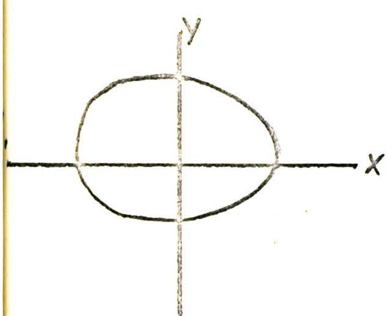

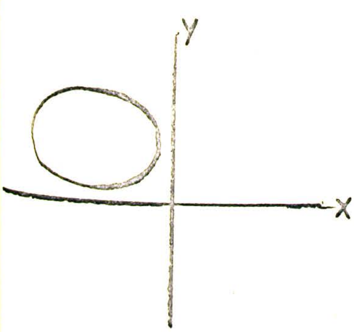

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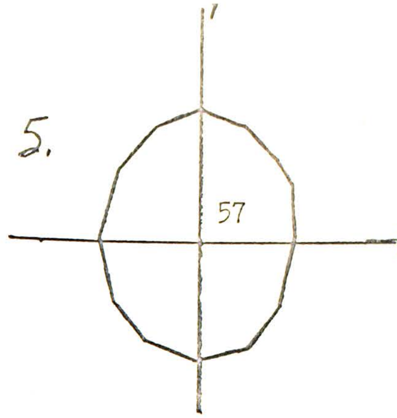

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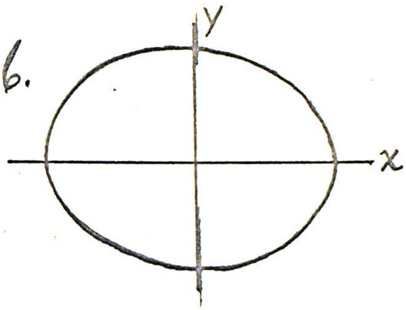

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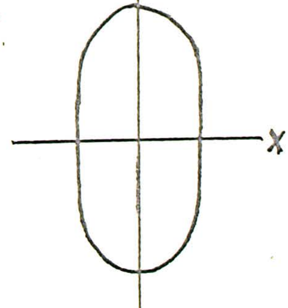

TEST 5

DIRECTIONS: SOME OF THE FOLLOWING EQUATIONS ARE SATISFIED BY SETS OF ORDERED PAIRS WHICH FORM THE LOCUS OF POINTS BELONGING TO AN ELLIPSE. CIRCLE THE NUMBER IN FRONT OF EACH SUCH EQUATION. THOSE THAT DO NOT BELONG TO THE SET OF EQUATIONS WHICH WILL FORM AN ELLIPSE WHEN GRAPHED ARE TO BE LEFT BLANK.

1. $25x^2 + 100y^2 = 100$

2. $3x^2 + 5y^2 = 10$

3. $x^2 - 26y^2 = 16$

4. $\frac{(x+1)^2}{25} + \frac{(y-2)^2}{36} = 1$

5. $4x^2 + 4y^2 = 16$

6. $\frac{3x^2}{9} - \frac{2y^2}{10} = 1$

7. $4x^2 + 9y = 36$

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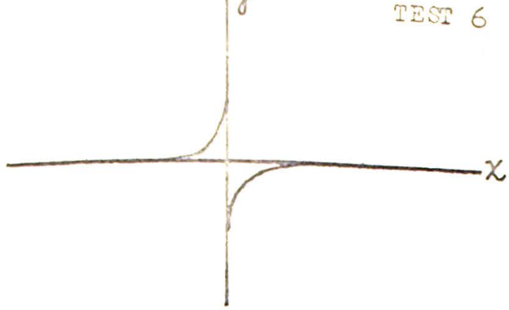

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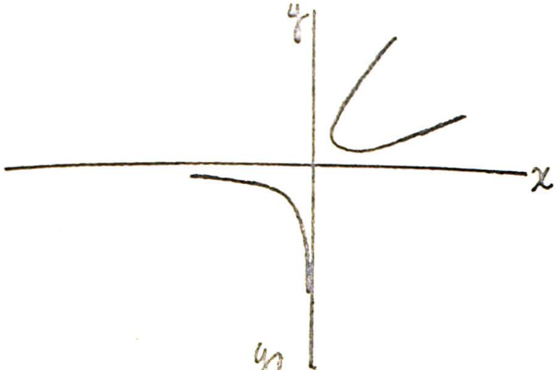

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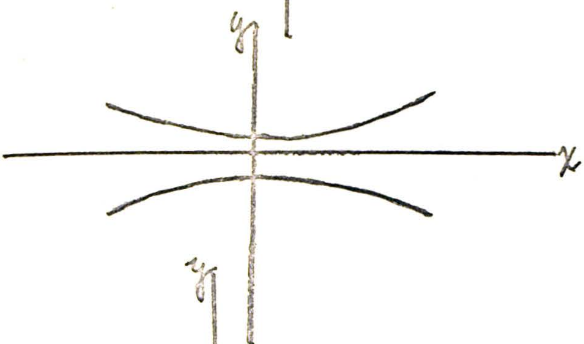

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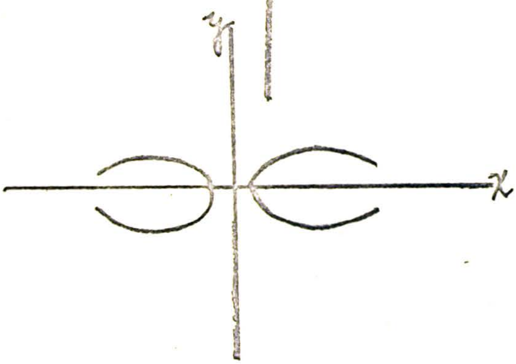

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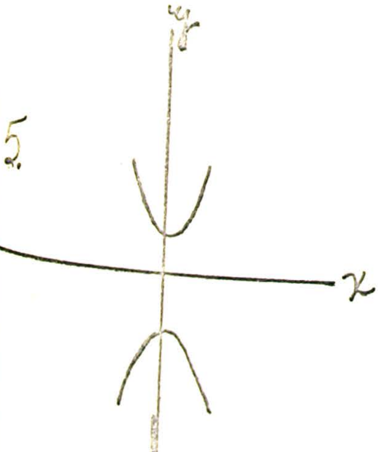

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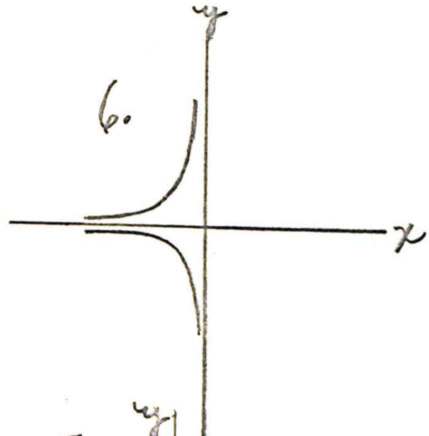

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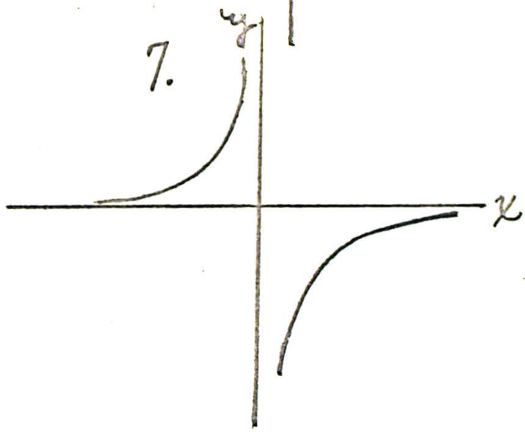

DIRECTIONS: SOME OF THE FOLLOWING EQUATIONS ARE SATISFIED BY SETS OF ORDERED PAIRS WHICH FORM THE LOCUS OF POINTS BELONGING TO A HYPERBOLA. CIRCLE THE NUMBER IN FRONT OF EACH SUCH EQUATION. THOSE THAT DO NOT BELONG TO THE SET OF EQUATIONS WHICH WILL FROM A HYPERBOLA WHEN GRAPHED ARE TO BE LEFT BLANK.

1. $x^2 - y = 100$

2. $x^2 = y^2 = 100$

3. $xy = 6$

4. $4y^2 - 36x^2 = 50$

5. $x^2 + 2y^2 = 16$

6. $4x - y^2 = 100$

7. $25x^2 = 36 + 9y^2$