

# The Use of Positive and Negative Examples During Instruction

## *Some Important Issues Related to the Design and Development of Instructional Materials*

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**Abstract.** This article is concerned with three main issues related to the use of positive and negative examples during instruction. The issues discussed are: sequence, quality, and quantity of positive and negative examples. Several ground rules concerning terminology and the place of examples in the instructional content have been established before elaborating on such issues. The article not only presents these issues, but also suggests some possible resolutions based upon the available research evidence and theoretical work in the field. The need to shift the emphasis from merely presenting both types of examples to the qualitative and quantitative relationships among them is stressed. It is hoped that the resolutions offered to the issues discussed will provide the intended users (teachers, instructional developers, etc.) with a natural starting point from which to master the technique of using effective positive and negative examples during instruction.

In recent years, the importance of providing students with both positive and negative examples during instruction has been widely recognized and strongly emphasized by many instructional psychologists and developers (Fleming and Levie, 1978; Merrill and Tennyson, 1977, 1978; Merrill and Wood, 1974; and Travers, 1977). The basic premise is that the use of both types of examples would prevent certain classification behavior errors from occurring during instruction; these are overgeneralization, undergeneralization, and misconception.

An overgeneralization error, which refers to a broad generalization, occurs

if the student classifies the negative examples of given generality (a concept, a rule, or a procedure) as positive examples of that generality. On the contrary, an undergeneralization error, which refers to a narrow generalization, occurs if the student classifies the positive examples of a given generality as negative examples of that generality. A misconception error, which means using the irrelevant attributes of the examples presented as being relevant attributes, occurs if the student classifies the positive examples which do not have such attributes as negative examples and the negative examples that do not have these attributes as positive examples.

The proponents of the previous proposition claim that a wide range of positive examples prevents undergeneralization, while a good selection of negative examples prevents overgeneralization. Accordingly, they conclude that a set which contains both types of examples should be used during instruction so that the student will not only learn the relevant attributes of the positive examples, but will also be able to discriminate against the attributes of the negative ones.

The previous proposition is supported by the theoretical work of Mechner (1965), Markle and Tiemann (1969), Merrill (1971) and Woolley and Tennyson (1972), as well as the empirical evidence derived from research on the role of positive and negative examples during instruction and on the relationships between these examples (Bourne and Guy, 1968; Huttenlocher, 1962; Merrill and Tennyson, 1978; Tennyson, Woolley, and Merrill, 1972; and Tennyson, 1973).

Mechner (1965) pointed out that in order to assess concept acquisition, the learner must be presented with both positive and negative examples until his/her ability to generalize to new positive examples and discriminate them

from new negative examples is observed.

Markle and Tiemann (1969) claimed that unless the relevant and irrelevant attributes of positive and negative examples were clearly contrasted, one of the three errors mentioned before would result. Merrill (1971) agreed with Markle and Tiemann that both positive and negative examples should be used during instruction and that the relevant and irrelevant attributes of these examples must be contrasted.

Woolley and Tennyson (1972), in their attempt to develop a theoretical model for concept learning, relied on the idea that positive and negative examples should be used together during instruction.

Although some studies on the role of positive and negative examples during instruction indicated that a set of positive examples alone was better than a set of negative examples alone or even a set of mixed positive and negative examples (Bourne, 1966; Hovland and Weiss, 1953; and Smoke, 1933), other studies showed that a set of both types was better than a set of all positive or a set of all negative examples. Huttenlocher's (1962) findings as well as Bourne and Guy's (1968) results indicated that a set of positive and negative examples was superior to a set of all positive ones.

Merrill and Tennyson (1978) found significant differences between students receiving positive and negative examples and students receiving a placebo in place of these examples in favor of those given both types of examples.

In light of the previous presentation, it might be expected that most instructional designers would readily agree that presenting the students with both positive and negative examples is an essential element in designing and developing any piece of instruction.

Merrill and Wood (1974), in their attempt to develop an instructional

strategy taxonomy, indicate that effective instructional strategies often make use of what they called "nonexamples" (negative examples) as well as "examples" (positive examples) in presentations. Wager and Broderick (1974) also point out that any materials designed to teach concepts must provide the students with what they termed "instances" (positive examples) and "noninstances" (negative examples), because both are apt to be important to the learner's understanding of the concept.

The use of both positive and negative examples in instruction, however, creates some important issues which the instructional designers and developers have to deal with when they attempt to design and develop a piece of instruction. Such issues are related to the sequence, quality, and quantity of the examples presented. Specifically, these issues are concerned with the way positive and negative examples should be arranged and ordered in a set which contains both types, the characteristics or features of the examples in such a set, and the number as well as the ratio of these two types of examples. Apparently, such issues deal with some of the most important variables and parameters of instructional design which, when determined and specified, might have value in the construction of a viable theory of instructional design.

Before elaborating on these important issues, two points need to be presented and clarified to establish several ground rules or points of view that may provide some new insights in this field. The first is related to the different terms used to designate the two types of examples. The second deals with the place of these examples in the instructional content.

### **Eliminating Confusion About Terminology**

A survey of the literature dealing with the use of examples during instruction indicates that terminology in this area has not yet been standardized. There is a great deal of inconsistency, not in defining the examples, but in using the terms which designate their types. Most instructional designers refer to different terms to mean the same thing. Some refer to examples and non-examples; others use instances and non-instances. Still others refer to positive examples and negative examples. Some other terms, such as exemplars and non-

exemplars, positive instances and negative instances, are also being used.

It should be noted here that a necessary first step toward the construction of a viable theory of instructional design is to establish a common terminology or vocabulary for the components of any proposed instructional strategy. Accordingly, it is important that confusion about terminology in this area be eliminated.

Two of the terms mentioned previously will, in this writer's opinion, help facilitate the communication process among designers, developers, writers, and even the average reader.

For purposes of clarity and simplicity this writer prefers the use of the terms "positive examples" and "negative examples" to the other previously mentioned terms. Accordingly, the reader will find an internal consistency in using these two terms with the rest of this article.

### **The Place of Positive and Negative Examples in the Instructional Content**

This writer is opposed to the proposition taken by some instructional designers that positive and negative examples belong only to the area of concept learning. The use of both types of examples should not be limited to this particular area simply because school subjects include different content areas. A short instructional unit or even a typical instructional lesson would include various types of content such as rules and procedures.

Positive and negative examples are needed in rule learning to illustrate the scope of the rule's application and to focus the learner's attention on the different situations where the rule can or cannot be applied. Additionally, the use of both types of examples would focus the learner's attention on the relevant features of the rule statement (generality which describes the rule). The same can be said in the case of procedure learning.

The nature and definition of positive and negative examples which belong to concepts, however, differ from those which belong to rules and procedures. This demands that positive and negative examples which belong to each content area be defined.

#### **Necessary Definitions**

*Positive example.* For a concept, a positive example is a true member of the

concept class which contains all the critical attributes of the concept in their appropriate relationship. For a rule or procedure, a positive example is an appropriate and correct application of the rule or the procedure.

*Negative example.* For a concept, a negative example is a false member of the concept which contains none or some of the critical attributes of the concept in their appropriate or inappropriate relationships. It may also contain all the critical attributes of the concept, but in an inappropriate relationship. For a rule or procedure, a negative example is an inappropriate application of the rule or the procedure.

*Concept.* A class of events or symbols that share critical attributes, can be referenced by a name, and have different individual members.

*Procedure.* A series of steps showing how to perform a task.

*Rule.* A relation which states how to produce one thing given another.

Although many studies have dealt with the use of positive and negative examples in concept learning (see Clark, 1971), little has been done on the use of these examples in rule learning. The role of both types of examples in procedure learning has not yet received any attention.

### **Issue 1: Sequencing of Positive and Negative Examples**

Sequencing of positive and negative examples used during instruction has been a topic of debate and a subject of research in recent years. The basic issue is whether positive and negative examples should be sequenced by example type or according to the characteristics of these examples. Sequencing by example type refers to the grouping of each type of example together, that is, presenting all positive examples followed by all negative ones or vice versa. Sequencing by characteristics refers to the ordering and arranging of the examples based upon the nature of the relationships between them.

Resolving such an issue also requires supplying answers to questions like the following: Which type of example should be presented first? Having decided on which type should precede the other, should the positive and negative examples be presented to the learner side by side, or should they be presented to him/her one after another?

The sequence issue and the questions which stem from it might be related to

instructional effectiveness. In fact, sequence variables have been considered seriously by many instructional theorists. Ausubel (1963) postulates that none of the possible conditions that affect cognitive structure can be more significant than the internal logic and organization of the material.

Glaser (1968) points out that the order and sequence in which positive and negative examples of a concept are presented to the student would seem to have a significant influence on concept learning. Merrill and Wood (1974) also mention that an inadequately sequenced content structure provides a limit on the learning outcome of a given instructional strategy regardless of what is done in manipulating other strategy variables.

Based upon the previous presentation, it can be concluded that decisions as to how positive and negative examples should be sequenced need to be made on some empirical bases when a piece of instruction is to be designed and developed.

The findings of a recent study conducted by this writer (Ali, 1980), as well as the findings of an earlier study conducted by Hovland and Weiss (1953), have demonstrated that sequencing examples by example type is not sufficient for effective instruction. The data from these studies indicated that series of positive followed by negative examples were equal to series of negative followed by positive examples. Such a conclusion implies that positive and negative examples might be used effectively during instruction when sequenced according to the qualitative relationships between them. This conclusion provides additional support to the findings of studies conducted by Merrill and Tennyson (1978), Stolurow (1975), Tennyson, Woolley, and Merrill (1972), Tennyson (1973), and Wager and Broderick (1974) on the sequencing<sup>1</sup> of positive and negative examples according to their characteristics. The results of these studies have indicated that: (a) the relationships between positive and negative examples are critical for adequate instruction; (b) a positive example should be contrasted with a matched negative one; (c) each positive example should be divergent from the previously presented positive examples; and (d) a range of easy-to-difficult positive and negative examples should be used.

#### Resolving Issue 1

The findings mentioned previously

suggest general criteria for the sequencing of both positive and negative examples. Accordingly, the issue of sequencing by example type versus sequencing by characteristics might be resolved. Simply, positive and negative examples should not be sequenced by example type, that is, by grouping each type of examples together. Instead, pairs of one positive followed by one negative example should be presented. The relationship between the one positive and the one negative example is the factor that should determine, not only each positive/negative example pair, but the order of all pairs. Obviously, the emphasis here is on the characteristics and relationships of both positive and negative examples.

Two questions are related to this issue. First, in each positive/negative example pair, should the positive example be presented before the negative one, or should the negative example precede the positive one? Second, having decided on which type should precede the other, should the two types in each pair be presented side by side or one after another?

Concerning the first question, some available evidence on the use of positive and negative examples indicates that positive examples are more effective than negative examples as usable sources of information (Bourne, 1966; Hovland and Weiss, 1953; and Smoke, 1933). Negative examples provide less information about the task being taught than do positive examples. This is because negative examples do not include all the critical attributes of the task. Accordingly, if the initial example presented was a negative one rather than a positive one, the difficulty of the task might be increased.

Based upon the focusing strategy proposed by Bruner, Goodnow, and Austin (1956), without the use of a positive example as a focus, a negative example alone provides less information about the task under consideration and requires more time for processing. By choosing a positive example as a focus, the complexity and abstractness of the learning task can be decreased because it helps direct the attention of the student to the relevant attributes of such a task. Accordingly, the initial example presented should be as representative of the task being taught as possible, that is, a positive example.

With regard to the presentation of

positive and negative examples one after another or side by side, there is some evidence that the side by side format facilitates learning (Travers, 1977). But the decision in this case depends upon the nature of the examples. Pictorial examples can be presented side by side for this helps the learner distinguish between the two. Verbal examples can be presented one after another if they are too lengthy, otherwise, they should be presented side by side.

The relationship between positive and negative examples which determines each positive/negative example pair and the order of all pairs involves variables such as divergency, convergency, match, and probability. These are elaborated below.

#### Issue 2: Quality of Positive and Negative Examples

Almost all the proponents of using both positive and negative examples during instruction would readily agree that students learn better when they are presented with "good" positive and negative examples. But, what are the characteristics of good positive and negative examples?

In fact, the degree of relatedness among positive and negative examples used during instruction is more important than just presenting the learners with both types of examples. Merrill and Tennyson (1978) indicate that merely presenting positive and negative examples is not sufficient for adequate instruction. What seems to be more critical for adequate instruction is the nature of the relationships between these examples.

The instructional developer who uses both positive and negative examples faces some questions like the following: Should positive and negative examples be similar to each other, or should they be different? Should the negative examples presented be similar to each other, or should they be different? Should the positive examples presented be similar to the negative ones, or should they be different? Should the positive examples be contrasted with the negative ones? Should both types of examples be difficult, that is, too abstract, or should they be easy, that is, too concrete?

#### Resolving Issue 2

It is suggested by many instructional scientists that there are qualitative relationships between all positive examples,

all negative examples, and both positive and negative examples. The presence of such relationships increases the effectiveness and efficiency of the instructional material which includes both types of examples. The theoretical work of Merrill and Wood (1974) identifies qualitative relationships. The empirical work of Merrill and Tennyson (1978), Tennyson (1973), Tennyson and Tennyson (1975), and Tennyson, Woolley, and Merrill (1972) has proven that these qualitative relationships are necessary for the effective and efficient use of positive and negative examples during instruction.

The qualitative relationships among the examples, which can be called the attributes of good positive and negative examples, are presented below.

*Divergency.* Divergency refers to the qualitative relationship between positive examples presented. That is, positive examples should be as different as possible in terms of their irrelevant attributes.

It should be noted here that there are relevant and irrelevant attributes of the examples presented. Relevant attributes of an example are those distinctive features of the example which make it differ from other examples, so they should be common or similar across positive examples. Irrelevant attributes are those which are not basic to the presentation of the examples; they can be varied across examples.

Irrelevant attributes include features such as size, shape, and length. Positive examples can be made divergent by changing their size, shape, and/or length. These help learners focus on distinguishing characteristics and recognize new positive examples which differ from those used during instruction, thereby preventing overgeneralization.

*Convergency.* Convergency refers to the nature of the relationship among negative examples. Little has been written on such a relationship. Merrill and Wood (1974) mention that, for most situations, such a relationship is not of interest to many designers and developers. One might speculate that this relationship is not of interest to the learners. In fact, while positive examples should be divergent, negative ones should be convergent or similar. The main purpose for using negative examples is to call learners' attention to the critical attributes of the positive ones; therefore, using divergent negative ex-

amples does little for understanding. Moreover, the use of divergent negative examples might only confuse learners.

*Match.* Match refers to the nature of the relationship between positive and negative examples. In this case, the irrelevant attributes of positive and negative examples should be similar as possible. The negative example should be as similar to the positive one as possible without sharing the critical attributes. Both can be of the same type and style. The use of similar positive and negative examples helps learners recognize features which characterize the positive ones. Using the negative example in this case sharpens learners' capacity to distinguish between the generality under consideration and other similar generalities. This prevents overgeneralization.

*Probability.* Probability refers to the range of both positive and negative examples used. Not all examples presented should be easy, neither should they all be hard. If easy examples are presented, learners may have trouble identifying hard ones. On the other hand, if hard examples are used, the students may have trouble identifying new ones. In such a case, the learning task will be unpleasant. As a result, range of easy-to-hard examples should be used.

The difficulty level of examples used can be determined experimentally or by using criteria related to the nature of the examples. Tennyson and Boutwell (1974) describe a procedure for determining the level of difficulty of the examples prior to the development of instructional materials. Such a procedure results from item analysis.

Examples range from very concrete to very abstract and from highly personal to highly impersonal. There is some evidence that concrete information is easier to learn and remember than abstract information (Fleming and Levie, 1978). Accordingly, the use of concrete examples should precede the use of abstract ones. Similarly, personal examples should be presented, whenever possible, before impersonal ones.

Another way to arrange examples by difficulty level is related to the number of irrelevant attributes that the examples possess. Examples can be made easier to learn by reducing the number of irrelevant attributes included in the examples. Increasing the number of irrelevant attributes would increase the difficulty

level of the examples presented. Accordingly, initial examples presented should include few irrelevant attributes to make the critical attributes obvious. Then those examples which have more irrelevant information should be presented. Simplified drawings can be used in presenting the initial examples because they reduce irrelevant attributes.

### Issue 3: Quantity of Positive and Negative Examples

This issue is receiving much attention. Quantity refers not only to the number of examples presented but to the ratio of positive to negative examples.

A question of considerable practical importance in the design of instructional materials is the extent to which learners can be expected to profit from a specific number and ratio of positive and negative examples used in a given learning situation. In fact, the number and ratio of positive and negative examples are related to the length and time variables of instructional design. From an economic point of view, the use of a short segment of instruction would cut the time and effort expended by both the developer and the learner who is to work with the material. Some important questions are related to the number and ratio of examples: How many positive and negative examples should be presented before or after a given generality to increase the effectiveness and efficiency of the instructional material? What ratio of positive to negative examples would increase the effectiveness and efficiency of the instructional material that includes both types of examples?

### Resolving Issue 3

Concerning the ratio of positive and negative examples, the results of many studies in this area suggest that increasing the proportion of positive examples facilitates learning. The findings of Hurley (1973), and Smuckler (1967) indicate that the 3:1 ratio of positive to negative examples is better than 1:3 ratio. In addition, the findings of Dossey and Henderson (1974) show that the 2:1 ratio of positive to negative examples is better than the 1:2 ratio.

In a study conducted by this writer (Ali, 1980), ratios of 1:1, 2:1, and 3:1 positive to negative were found equal in terms of three dependent variables: (a) number of errors occurring during instruction; (b) posttest time; and (c) posttest score. In terms of learning time,

however, the 1:1 ratio produced significantly less mean learning time than the 3:1 ratio of positive to negative examples.

The results of these studies indicate that instructional materials should *not* include more negative than positive examples. The number of positive examples should be *equal* to or *greater* than the number of negative ones. Using positive/negative example pairs suggests that the 1:1 ratio of positive to negative examples should be employed.

The total number of examples (both positive and negative) to be used depends upon the nature of the task under consideration and the characteristics of the student who is to work on the material. Moreover, the optimal number of examples used depends upon the type of learning environment (i.e., mastery and nonmastery conditions).

Studies dealing with the optimal number of positive and negative examples to be used during instruction need to be conducted. Until the findings of such studies are available, four examples (two positive/negative example pairs) would be as many as could be presented before or after a given generality. The underlying assumption of this article is that more than one positive and one negative example needs to be presented before or after a given generality.

The term "rational set" proposed by Markel and Tiemann (1969) is used here to refer to the total number of examples that should be presented for a given generality. Accordingly, one would say that each rational set should include a total of four positive and negative examples. It is recommended that the learner be tested upon the presentation of each rational set by determining his/her ability to discriminate between positive and negative examples and recognize new ones not used during instruction. If the learner does not demonstrate such an ability, that is, if the criterion is not met, another rational set belonging to the same generality should be presented to him/her. The procedure should continue in the same manner until the criterion is met.

## Implications

The issues presented in this article and the resolutions suggested have a number of important practical implications for the development of instruction, the con-

struction of a theory of instructional design, and the conduct of instructional research. A deliberate attempt has been made to separate and identify the resolutions suggested.

1. Instructional developers should consider both positive and negative examples as important and necessary components of any instructional strategy.

2. Including positive and negative examples in any instruction does not guarantee that such instruction is effective. To be effective, the qualitative and quantitative relationships among the examples should be taken into consideration.

3. The resolutions offered to the issues presented might lead to the construction of a useful and valid instrument that could be used in examining different instructional materials to determine the effectiveness of positive and negative examples. An instrument like this could be used, not only as an analytic tool, but as a design-decision tool as well.

4. The issues presented in this article reveal the necessity for the construction of a strong theory of instructional design. The resolutions offered might have value in providing information concerning some of the variables of instructional design such as those related to sequence, quantity, and quality of the components of any proposed instructional strategy.

5. The attempt made in this article to resolve the issues presented might contribute to progress toward the construction of a prescriptive theory of instructional design by stimulating further empirical and theoretical work in this important area of instructional science. If this happened, agreement on basic terms might be reached and the variables, parameters, and principles of instructional design could be identified.

6. Results of studies revealed in this article indicate that additional field research needs to be conducted to determine the interactive relationships between the qualitative and quantitative variables of instructional design as they may relate to the use of positive and negative examples during instruction. Such qualitative and quantitative variables have been studied independently without giving attention to their interactive influences. This suggests types of instructional research needed to supply answers to questions like the following:

a. How many elaborated examples (as opposed to non-elaborated ex-

amples) should be presented before or after a given generality?

b. How many examples with attention focusing devices (as opposed to examples without attention focusing devices) should be presented before or after a given generality?

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