Empirical Theory Construction and Hypothesis Formation

Elizabeth Steiner Maccia
The Ohio State University
May, 1964

BUREAU OF EDUCATIONAL RESEARCH AND SERVICE / THE OHIO STATE UNIVERSITY

BERS

Empirical Theory Construction and Hypothesis Formation

Elizabeth Steiner Maccia
The Ohio State University
May, 1964

Purpose of Hypothesis Formation

The purpose of hypothesis formation is to make explicit the relations of variates. Through such explication, relations of aspects of reality are specified. Specifications, then, can be evaluated. If proven adequate, prediction and thus control are possible.

Forms of Hypotheses

The general form of a hypothesis is a proposition. A proposition is a statement which is true or false. Statements are relations of terms, i.e. relations of variates. On the basis of the manner of relating variables, three types of propositions will be distinguished:

1. classificatory

   All X is Y

2. relational

   X bears the relation R to Y

3. conditional

   $X \rightarrow Y$

Classificatory Propositions

In the classificatory propositions, a term which determines one class is related to another term which determines another class, so that the former class is included in the latter class. What is being asserted is that one variate is invariably associated with another variate, i.e. whatever has the characteristic X has the characteristic Y. To be more

precise, then, the classificatory proposition is symbolized as:

$$(x)\,(Xx \supset Yx)$$

where '$(x)\,(\quad)$' stands for each x is such that

'Xx' x has the characteristic X

'Yx' x has the characteristic Y

'$\supset$' if . . . then

This symbolic statement is read as follows:

> Each x is such that if x has the characteristic of X then x has the characteristic of Y.

An example of a classificatory proposition that relates the variates, approving teacher behavior and socially integrative teacher behavior, is as follows:

> Each instance of teacher behavior is such that if it has the characteristic of being approving then it has the characteristic of being socially integrative.

Relational Propositions

Although classificatory propositions relate variates, in logic propositions in which relations are dyadic, triadic, tetradic, etc., are called 'relational'. Dyadically relating terms is to conjoin them with respect to a relation. What is being asserted is that two variates may be invariably associated with respect to a relation, i.e. whatever has characteristic X and whatever has characteristic Y are related in a certain way. To be more precise, the relational proposition is symbolized as:

$$(x)\,(y)\,(Xx \cdot Yy \,.\supset Rxy)$$

where '$(x)\,(y)\,(\quad)$' stands for each x and each y is such that

'Xx'	x has the characteristic of X
'Yx'	x has the characteristic of Y
'$\supset$'	if . . . then
'Rxy'	x bears the relation R to y

This symbolic statement is read as follows:

> Each x and each y is such that if x has the characteristic of X and y has the characteristic of Y then x bears the relation R to y.

An example of a relational proposition that relates the variates, discussion teaching method and lecture teaching method, is as follows:

> Each instance of one teaching and each instance of another teaching is such that if the former has the characteristic of discussion method and the latter has the characteristic of lecture method then the instances of discussion method are more effective than the instances of lecture method.

Characteristics of Relations

Relations may be symmetric, asymmetric, transitive, intransitive, reflexive, and irreflexive.

Symmetric Relation:	a relative term is symmetric if the relation borne by x to y is not borne by y to x, i.e. $(x)(y)(Rxy \supset Ryx)$ e.g. equal to
Asymmetric Relation:	a relative term is asymmetric if the relation borne by x to y is not borne by y to x, i.e. $(x)(y)(Rxy \supset -Ryx)$ e.g. greater than
Transitive Relation:	a relative term is transitive if the relation borne by x to y and y to z is also borne by x to z, i.e. $(x)(y)(z)(Rxy \cdot Ryz .\supset Rxz)$ e.g. equal to, greater than

Intransitive Relation: a relative term is intransitive if the relation is borne by x to y and y to z is not also borne by x to z,
i.e. $(x)(y)(z)(Rxy \cdot Ryz \supset \sim Rxz)$
e.g. father of

Reflexive Relation: a relative term is reflexive if the relation is borne by x to itself, i.e. $(x)(Rxx)$
e.g. coexistent

Irreflexive Relation: a relative term is irreflexive if the relation is not borne by x to itself, i.e. $(x)(\sim Rxx)$
e.g. greater than

The importance of understanding the characteristics of relation is illustrated by the fact that in establishing an ordering, such as ranking which plays an important role in the behavioral sciences, symmetry, transitivity, and reflexivity must be present.

Some Important Types of Relational Propositions

Two important types of relational propositions are sequential propositions and functional propositions.

Sequential Propositions: In a sequential proposition the dyadic relation involved is later than. An example would be

> In concept formation, descriptions that are symbolic follow descriptions that are personal.

Functional Propositions: In a functional proposition, there is a relating of instances in regard to characteristics so that a set of ordered pairs emerges. A functional proposition may be symbolized as follows:

$$f(Y) = X$$

where 'f(Y)' stands for function of Y

A function maps values of Y into X. When the instances of X and Y can be given numerical values, then the more common sense of mathematical function emerges, i.e. a set of ordered pairs of numbers. An example would be pressure as a function of volume. The standard form of hypotheses in the theoretically most advanced branches of empirical inquiry are in the form of functional propositions which contain terms susceptible to quantification.

Conditional Propositions

A conditional proposition relates two variates as conditions of one another. This proposition was symbolized as

$$X \rightarrow Y$$

where ' $\rightarrow$ ' is used rather than ' $\supset$ ' to distinguish the general conditional from the molecular conditional

Conditional Propositions may be sufficient, contingent, necessary, or substitutable.

Sufficient Conditional Proposition: $X \rightarrow Y$, where X is a sufficient condition for Y, i.e. X is the only condition needed to get Y

Contingent Conditional Propositions: $X \rightarrow Y$, where X is not a sufficient condition for Y but requires other conditions as well
e.g. permissiveness of climate is not a sufficient condition for group-problem solving but requires at least that one member of the group could have solved the problem alone
It is through contingent conditional propositions which are so common in regard to behavioral phenomena that propositions are multivariate not two-variate.

Necessary Conditional Propositions: $X \rightarrow Y$, where Y is a necessary condition of X, i.e. Y cannot be absent when X occurs
e.g. permissiveness of climate might be a necessary condition of group-problem solving

Substitutable Conditional Propositions: $X \rightarrow Y$, where another condition could be substituted for X, i.e. X does not need to be present when Y occurs
e.g. video tape presentation may be substituted for live presentation for learning to occur

A Hypothesis Form of Singular Importance

With respect to behavioral phenomena, interaction is important. This interdependent relation is present when the following conditions are met:

> If x changes from x_1 to x_2, and $x_2 = x_1 + \Delta x$, then and only then, y changes from y_1 to $y_1 + \Delta y$; further when y changes from y_1 to y_2 and $y_2 = y_1 + \Delta y$, then and only then, x changes from x_2 to $x_2 + \Delta x$, etc.
>
> where Δx and Δy are small increments of variables x and y, respectively

An example would be an increase in teacher punitive behavior leading to an increase in student aggressiveness, and a further increase in student aggressiveness leading to a further increase in teacher punitive behavior, and a further increase in teacher punitive behavior etc.