

Chapter 5: Research Language

Published Examples of Research Concepts

Contents

Constructs, Types of Variables, Types of Hypotheses

Note Taking and Learning

References

Constructs, Types of Variables, Types of Hypotheses

Note Taking and Learning

Based on an honors thesis by Leslie Shrager at the University of California at Santa Barbara, Shrager and Mayer (1989) tested whether taking notes (or not) influenced the learning of subjects with more versus less knowledge of the lecture topic (how to use a camera). In the broadest sense, the construct being investigated was “learning.” Recall that a construct is a complex abstraction, an inference about something presumed to exist “in the mind.” As is true for all constructs, this abstraction had to be translated by the researchers into operational terms which are clearly measurable (observable).

Like much educational research, this study was driven by theory, namely, generative theory. Generative theory emphasizes the important role of learners’ actively constructing, or generating, their own understanding by building mental frameworks, making connections, creating metaphors, and so on. The value of clearly linking the role of theory in producing the research hypotheses, be it generative theory or otherwise, is that the findings may support the theory, which itself will help us understand in a much broader sense how students learn. A credible theory, then, does a good job explaining a construct, and the practical implications of a credible theory can lead to improved teaching and enhanced learning (“theory into practice”).

These researchers presented to readers a precise statement of the research hypothesis, or expected relationship: “Note-taking would result in improved problem-solving transfer and semantic recall but not verbatim recognition or verbatim fact retention for low-knowledge learners but would have essentially no effects on test performance” (p. 263). Recall that the hypothesis is *not* a vague statement about many different relationships which could be found. It is a very specific relationship, one expected by the researchers, if in fact the theory which spawned the hypothesis is correct.

From this hypothesis, one can see that “learning” is defined using a four-pronged approach: transfer, recall, recognition, and retention. It is no surprise that a construct as complex as learning was defined multidimensionally. Each one of these facets of learning must be operationally defined in some meaningful way, as it indeed was. Recall that operational definitions describe the rule for “putting numbers next to names.” This is an important description in any research study, for it not only allows replication to take place (as is also true with the description of the independent variable), it provides information for readers’ evaluation of the worth of their definitions. If operational definitions are poor translations of the construct, then the researchers are simply not studying what they intend to study.

The researchers’ hypothesis also suggested how this research arranged for the operation of its independent (manipulated), dependent (outcome), and attribute (subject characteristic) variables. Although complex, this hypothesis suggests the independent variable is note taking (with levels being yes or no), the dependent variables are four separate assessments of different learned outcomes, and the attribute variable is the level of subjects’ prior knowledge (of camera use).

Researchers usually describe in some detail the manipulation which defines the independent variable, in part so that other researchers can replicate, or repeat, the study. Of the two subtypes of independent variables (true independent and quasi-independent), Shragar and Mayer's independent variable is regarded as a *true* independent variable (as opposed to a quasi-independent variable) since its categories (taking notes, not taking notes) were created by the researchers and learners could be assigned randomly to each condition (a manipulation). True independent variables, recall, are far better suited than quasi-independent variables for the purpose of establishing cause and effect.

As expected by their hypothesis, these researchers used four dependent variables: a recall test score, transfer test score, verbatim recognition test score, and a verbatim fact retention score. These tests were designed by the researchers themselves and the scores are considered the operational definitions of the four types of learning (recall, transfer, recognition, and retention). Each measure is also a dependent variable. Recall that many studies include multiple dependent variables. Remember also that dependent variables refer to the measured outcome, that is, the numbers within a table presenting the findings. One can quickly determine a study's dependent variable by zeroing in on the table (or tables) that present the findings. The label for the values in the table (the numbers themselves) often describe the dependent variable.

Not all studies include attribute variables, but such variables are needed whenever there is an expectation that some subjects may respond differently to the independent variable (manipulation), leading to "It depends" statements. This was clearly suggested by these researchers' hypothesis. Recall subjects were self-assigned to categories of attribute variables on the basis of some preexisting characteristic, in this case, level of

prior knowledge. This attribute variable was important for testing this specific research hypothesis, for it was predicted that low-knowledge learners would respond to the treatment (note taking) differently than high-knowledge learners did.

All researchers must also confront the existence of extraneous variables, those influences which can affect the dependent variable (or variables, in this case) but are not relevant to the research hypothesis. As such, their influence must be controlled. The “procedure” section of a published research article describes the tactics and strategies used for the control of extraneous variables. Researchers, whenever possible, use one very powerful method of control: randomization. As expected, Shrager and Mayer randomly assigned subjects to categories of the note-taking independent variable. This was an attempt to equalize (control for) extraneous influences related to the learners themselves, such as aptitude, interest, motivation, vision, hearing, and so on as these influences would tend to spread out equally across the note-taking and non-note-taking groups.

As we have seen, extraneous variables which are not controlled can sometimes result in disastrous problems such as a confounding. For example, if learners merely chose, by signing up, either the note-taking or non-note-taking condition, it is plausible that more enthusiastic learners would congregate in the note-taking condition (instead of being “stuck” in the control group). If the note-takers performed better than the non-note-takers, one would not know whether the difference was due to note taking per se or to a heightened interest level among the note-taking learners.

Another obvious confounding would be using a video presentation of the instruction for non-note-takers but a live presentation for the note-takers. If the note-

takers performed better, the effect could be caused by differences in the method of presentation as well as differences in note taking. How would you know which one caused the difference in outcomes? The point is that you would not.

Furthermore, the procedure section of published reports often reflects the researchers' concern about alternative hypotheses, those nasty worries about "what else could explain away the findings." All researchers have these worries. To the extent that the research procedures can eliminate (or at least render implausible) those alternative explanations, the researcher is more confident that the independent variable, and nothing else, caused the obtained differences in the dependent variables. For example, all the learners in the study of note taking were tested alone or in small groups (up to four people). One alternative hypothesis for the findings might be that note-takers did better because the non-note-takers simply did not pay attention to the videotape. This argument would seem more plausible if learners were tested in groups of 40, where there undoubtedly exist more distractions or maybe greater anonymity ("lost in the crowd" reactions). Simply, one is more likely to "phase out" in a larger crowd, and get away with it. This alternative hypothesis cannot be ruled out definitely, but it seems less plausible in small groups.

Recall from the earlier discussion that researchers must attend to another type of hypothesis in addition to the research and alternatives ones—the null hypothesis. Recall also that this is a difficult concept, described more fully in Chapter 13, but for now we know that the null hypothesis is nearly always one that the researcher wants to "reject." This is because the null hypothesis is a statement that there is no relationship among the variables being studied. The researchers' p value, generated by statistical software, tells

us how likely it is that the null hypothesis is true. Shrager and Mayer's p value was less than .01, which means that the null hypothesis was probably not true. (There is less than 1 in 100 chances that it is true.) Because their null hypothesis can be rejected as not being very likely, these researchers were entitled to conclude that its opposite—the research hypothesis—is probably true.

In short, the practice of educational research uses its own language in special ways, and the Shrager and Mayer study was no exception. This practice often involves a theory (generative theory), a research hypothesis describing independent and dependent variables (note taking results in improved learning), constructs and operational definitions (e.g., transfer learning as evidenced by number of points earned on a test), control of extraneous variables (e.g., random assignment), data collection (learners were tested in small groups), analysis (note-takers recalled more, $p < .01$), and the interpretation or conclusion (e.g., note taking fosters generative learning strategies).

References

Shrager, L., & Mayer, R. E. (1989). Note-taking fosters generative learning strategies in novices. *Journal of Educational Psychology*, *81*(2), 263–264.