White Paper

Transfer of Learning

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I. Introduction

Current educational standards including the Common Core State Standards (CCSS) and state-specific standards call for the development of capabilities that go beyond those called for in past standards-based education initiatives. Until recently assessment of standards mastery focused on the extent to which students learned what was taught. The new standards require not only the learning and retention of knowledge targeted for instruction, but also the ability to use information in ways that go beyond what has been explicitly taught. Specification of the types of capabilities involved in the mastery of the new standards may be found in Norman Webb's classification of standards according to the depth of knowledge (DOK) required for standards mastery. The discussion that follows addresses the transfer of learning, which supports development of the kinds of capabilities reflected in the new standards and can play an important role in measuring mastery of the new standards.

Transfer occurs when learning one thing affects learning something else. For example, when a student studies a great work of art such as a Shakespeare play, the intent of instruction goes beyond the student acquisition of specific information about Shakespeare, the play under study, and the culture at the time the play was written. The aim is to increase understanding in ways that apply more generally to other works of art, other times, and other circumstances. The concept of transfer of learning provides a framework for measuring the generalization of learning beyond the content specifically targeted for instruction.

The notion of transfer was introduced by Edward Thorndike and Robert Woodworth more than one-hundred years ago. Since that time, the idea of transfer has become a key component of the succession of theoretical perspectives that have provided the framework for our understanding of learning, memory, and cognition. Each of these perspectives has made unique and lasting contributions to our understanding of transfer. These contributions provide a wealth of information that can be used to guide instruction designed to address new standards calling for the development of advanced cognitive skills.

II. The Functionalist Perspective

The first perspective to be addressed is the functionalist perspective introduced by Robert Woodworth. Functionalists produced a number of important contributions to our understanding of learning, memory, and cognition. These contributions included advances in our understanding of transfer.

Functionalists argued that learning and memory could best be understood by identifying the factors of which learning and memory were a function. Their experiments on verbal learning identified a number of factors that are applied to this day to improve memory for verbal information. For example, functionalists demonstrated that recognition memory was superior to recall memory, information presented first or last was retained better than information presented in the middle of a list, and that transfer could be both positive and negative. The findings on transfer indicating the existence of both positive and negative effects continues to provide important guidance to educators. For example, when we multiply fractions, both the numerator and the denominator of the fractions are multiplied. When we add two or more fractions, the denominators of the fractions are not added. The fact that the denominators remain the same in

addition, but change in multiplication can produce a significant interference effect that must be addressed to support learning and retention involving the addition and multiplication of fractions.

III. Learning Hierarchies

New developments that led to increased understanding of transfer emerged during World War II. As the war effort gathered momentum, the capability to perform a wide range of new and challenging tasks became increasingly essential. Psychologists were called upon to analyze military tasks by breaking them into their component parts. The analytic approach enabled researchers to identify the kinds of skills needed to perform the various tasks determined to be necessary to effectively prosecute the war.

Following the War, Robert Gagne led a widely influential research initiative that applied the task analytic approach to the study of learning. Gagne reasoned that the elementary task components revealed through task analysis formed a hierarchical structure that defined the path of learning for the task under examination. Gagne set forth the view that learning hierarchies were composed of varying levels of component skills and that the acquisition of certain lower level skills was prerequisite to the acquisition of certain higher level skills.

Research on learning hierarchies led to the introduction of the concepts of lateral and vertical transfer of learning (Gagne, 1965). Lateral transfer occurs when initial skill acquisition affects the learning of a broad range of similar skills at roughly the same level of complexity. Vertical transfer occurs when a capability to be learned is mastered more rapidly when it is preceded by the acquisition of one or more subordinate capabilities. Research also revealed instances of downward transfer in which learning a superordinate skill eventuated in the simultaneous learning of one or more subordinate prerequisite skills. This surprising finding led to the important conclusion that the order of teaching need not necessarily be consistent with the order of learning.

IV. The Constructivist View

The constructivist view in psychology was introduced by Jean Piaget and effectively advanced by cognitive psychologists representing a variety of perspectives sharing the assumption that people are not passive receivers of information. Rather, they actively construct knowledge based on their experiences. Support for the constructivist view stems from a variety of research paradigms. A significant body of research reflecting the constructivist perspective has been informed by the kinds of mistakes that students make when responding to problems that they are not equipped to solve. For example, in the 1980s, John Sealy Brown observed that a large number of unprepared children confronted with math problems requiring borrowing followed a very simple and not entirely unreasonable rule: Always subtract the smaller number from the larger number. A child using this rule to subtract twenty seven from thirty four would get an answer of thirteen. Presumably no teacher taught the children in Brown's study the rule producing the observed incorrect outcome. Thus, Brown argued that the children came up with the rule themselves. While Brown's argument is reasonable, it is important to note that the rule adopted by the children does work for simple subtraction problems. The discussion below on rule replacement suggests that the rule the children followed may have been taught implicitly

during instruction involving simple subtraction problems. The children applying the simple rule had not yet replaced it with a more complex rule that would cover borrowing.

The rule replacement perspective is concerned with sets of rules that form a developmental progression supporting increasingly complex forms of problem solving. When rules and problems are developmentally sequenced, a simple rule may be replaced by a more complex rule enabling the individual to successfully address a more complex problem. For example, Bergan, Stone, and Feld (1984) designed a series of tasks to assess student knowledge of counting. The series included counting forward from one, counting on from a number greater than one, counting backwards, and counting by multiples. These tasks were shown to be hierarchically ordered reflecting the acquisition of a series of increasingly general rules broadening the range of counting tasks that could be performed. The most restrictive rule required that counting always begin with the number one and proceed forward in increments of one. The most advanced rule allowed counting to start from a number greater than one, to proceed either forward or backward, and to include increments greater than one.

The example given in the preceding paragraph reveals a development progression associated with a single cognitive skill or procedure, counting. Developmental progressions may also be linked to multiple procedures. For example, counting skills are required to support the development of addition and subtraction skills, and addition skills and subtraction are required to support the development of multiplication and division skills. The examination of multiple procedures invariably leads to complex developmental structures.

Another research initiative emanating from the constructivist perspective revealed that problem solving is influenced by the manner in which the individual represents the problem to be solved. For example, in one study (Lawler, 1981), a girl attending kindergarten was given the problem of adding seventy-five and twenty-six. Since the child had not been taught the carrying operation, she was not able to solve the problem. She was then asked for the sum of seventy-five cents and twenty-six cents. She responded “Three quarters, four quarters, and a penny make a dollar one.”

The Lawler study reveals two important findings related to problem solving and transfer of learning. The first is that whether or not a problem will be solved is affected by the way in which the problem is represented. Another way to say the same thing is to indicate that whether or not transfer of learning occurs may be affected by the way the transfer task is represented. The second important finding from the Lawler study is that it is possible to influence the way in which a problem or transfer task is represented. Assisting students to succeed in addressing transfer of learning tasks is among the most important current learning goals.

V. Measuring Transfer and Mastering Standards

The measurement of mastery of the new CCSS or state-specific standards and the measurement of transfer of learning are in some cases the same thing. To the extent that the new CCSS and state-specific standards call for the measurement of capabilities used with content other than that previously taught, mastery of the new standards implies transfer of learning. For example, if students participate in an instructional unit on the Shakespeare play *Romeo and Juliet* and the capabilities that the student has acquired are assessed using a different play, for example *Westside Story*, then both transfer of learning and mastery of the new standards are being measured.

The synergy between transfer and standards mastery has beneficial implications for both assessment and instruction. A focus on transfer in assessment design promotes the construction of measures closely aligned to the new standards and supports effective forecasting of statewide test performance. The specific literary works that are covered in local curriculums will probably not be the same as the literary works appearing on statewide test items. To the extent that local assessments measure the ability to use capabilities with new content or in a new context, forecasting is likely to be more accurate than it would be if the only available measures were limited to literary material covered explicitly in instruction. A focus on transfer can increase instructional effectiveness as well as effective assessment design. When learning one thing helps a student to learn something else, learning is accelerated. In addition, instruction that promotes transfer targets the development of advanced cognitive skills. The ability to use information in new ways to solve new problems reflects the kinds of advanced capabilities that arise through transfer and that are essential to meet the challenges of life in the current age.

VI. Text References

Gagné, R. M. (1970). The conditions of learning (2nd ed.). New York: Holt, Rinehart and Winston.

Brown, J. S. & VanLehn, K. (1982). "Towards a Generative Theory of Bugs," *Addition and Subtraction: a cognitive perspective*, Carpenter, T., Moser, J., & Romberg, T., (Eds.), Lawrence Erlbaum Associates, Hillsdale N.J.

Bergan, J. R., Stone, C.A., & Feld, J. K. (1984). Rule replacement in the development of basic number skills. *Journal of Educational Psychology*, 76, 289-299.

Lawler, W. (1981). The progressive construction of mind. *Cognitive Science*, *5*, 1–30.