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Incorporating Haskell's Theoretical Framework For Achieving General Transfer in the Content Areas

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ABSTRACT

Transfer of learning persists as one of the most vexing problems in our classrooms. In addressing this pivotal issue, Haskell proposed a theoretical framework for achieving general transfer that entails 11 learning and instructional principles. This article describes how to incorporate Haskell's theoretical framework in the content areas. Each principle of transfer is elucidated, specifically related to the most recent research undergirding it, and applied to a topic in secondary AP Physics and college freshmen physics: the theory of gravity.

Introduction

Haskell (2001) laments the current instructional zeitgeist because it mirrors our ambivalent attitude toward learning by employing quick fixes (e.g., skills, techniques, and algorithmic-like learning strategies) to foster transfer and learning. Unfortunately, this approach has consistently failed to ensure transfer due primarily to an inadequate theoretical base. Accordingly, Haskell has proposed a general theory of transfer that requires 11 learning and instructional principles in order for significant transfer and learning to materialize.

Haskell's Theoretical Framework for Achieving General Transfer

In order to resolve past and current failures of transfer of learning in the classroom, due predominantly to a perceived insufficient theoretical base, Haskell (2001) enumerated 11 learning and instructional principles in his theoretical framework for achieving general transfer. Each of these principles is simultaneously described and incorporated in teaching the theory of gravity in a secondary AP physics course and a college freshmen physics course.

First Principle of Transfer: Primary Knowledge Base

Learners must possess a large primary knowledge base in the content area requiring transfer (Haskell, 2001). A knowledge base is absolutely essential for transfer, plus thinking and reasoning, because transfer requires that learning be transformed into a generic form; moreover, this transformation can occur only if a large knowledge base already exists. Merely possessing a knowledge base, however, is insufficient. What is needed, rather, is a system of knowledge that is appropriately prepared to facilitate entry into a prepared cognitive system. A high knowledge base enables individuals to identify problems with great precision and speed by generating an initial representation of the problem that enables the expert to pursue the best path to a solution without the need to consider all others. In addition, such a knowledge base permits us to perceive patterns in our environment. Consequently, pertinent information is more efficiently accessed and retrieved (Glasser, 1987).

Physics application. A large primary knowledge base pertaining to the concept of gravity would entail—but not be limited to—a discussion about aspects of the following topics: acceleration, Albert Einstein, anti-gravity, anti-matter, black holes, curved space, dark energy, dark matter, density, diallel (gravitational-field lines), electro-magnetism, $E=MC^2$, $F = G[(m^1m^2)/r^2]$, force, force field, frames of reference, G (Universal gravitational constant), General Theory of Relativity, geodesic, gravitons, gravity waves, Isaac Newton, light, mass, M-theory, Principle of Equivalence, quantum, Quantum Mechanics, Schwartzchild radius, space-time continuum, Special Theory of Relativity, Supergravity Theory, Superstring Theory, Theory of Everything, Unified Field Theory (UFT), time dilation, volume, and weight.

Second Principle of Transfer: Peripheral Knowledge

Peripheral knowledge is essential if learners are to successfully experience significant transfer of learning (Haskell, 2001). Immediately useful knowledge, it should be noted, is frequently inadequate for general transfer or deep learning. So-called useless or irrelevant knowledge--relative to goals, context, and time frame--is required because so much of what we assume to be essential for transfer to occur is frequently counterintuitive. Transfer is significantly facilitated when a learning situation contains all of its irrelevant cues because irrelevant knowledge provides the learner with critical alternatives or choices between concepts during learning. Apparently, generic learning materializes because knowledge from various situations shares similar or identical structures.

Physics application. Peripheral knowledge germane to a discussion of gravity would include—but not be limited to—aspects of the following: acceleration, algebra, astronomy, calculus, electromagnetic forces, Euclidean geometry, magnitude, non-Euclidean geometry, plane trigonometry, speed, spherical trigonometry, strong forces, sub-atomic matter, vectors, velocity, and weak forces. Peripheral knowledge, rightly understood, should enable our much-touted interdisciplinary curricular and integrative learning within the educational establishment to facilitate transfer discoveries and to educate generalists.

Third Principle of Transfer: History of Transfer Area(s)

It is crucial that learners grasp the history of the content area(s) to be transferred (Haskell, 2001). Learning from history, whether it is on a personal, cultural, or subject matter level, is transfer par excellence because utilizing our past learning in order to apprehend and grasp the present constitutes the core definition of transfer. Coverage of the historical nature of an important topic or concept serves several functions for students and teachers: it delineates the content area(s) and its corresponding themes, thereby informing the students where the teacher is heading; it enhances sound scholarship by providing familiarity with the historical origins of the content area(s); it provides perspective to the current approach to a content area(s), which obviates our tendency to reinvent the wheel and/or to adopt faddish approaches to tackle a concept or topic; and it facilitates accurate reading of the classic material associated with the content area(s). A sense of history, therefore, is essential if transfer is to occur.

Physics application. An historical treatment of gravity might include, but not be limited to, aspects of the following scientists and their respective contributions: Aristotle: geocentrism, natural motion, and crystalline spheres; Aristarchus: heliocentrism; Ptolemy: geocentrism, epicycles, and deferents; Copernicus: heliocentrism, uniform circular motion; Tycoe Brahe: accurate astronomical measurements, a Copernican/Ptolemaic cosmology; Galileo: inertia, moons of Jupiter; Kepler: planetary motion laws; Newton: Universal Law of Gravitation; Einstein: General Theory of Relativity; Super String Theory: current attempts to construct a unified theory of the universe, uniting quantum mechanics and general relativity.

Fourth Principle of Transfer: Motivation

Motivation or a “spirit of transfer” is essential if learners are to experience significant and general transfer (Haskell, 2001). Haskell asserts that the spirit of transfer, which includes personality, attitudes, feelings, and motivation, is the key to significant and general transfer. Knowledge encoded for transfer will also be retrieved for transfer. Personality characteristics constitute one of the most significant variables influencing the encoding process because the personal meaning we infuse information with affects how information is encoded, retrieved, or related. Personal meaning tags information as either pertinent or irrelevant to current or novel situations and facilitates transfer (Biggs, 1989).

Physics application. Students need to be motivated while studying about gravity because a student’s retrieval of information is strongly influenced by the method he/she employs to encode or store it. Demonstrating how the concept, principle, or law of gravity personally impacts students’ lives and identifying numerous examples of it that apply on a daily basis are effective ways to motivate students to learn about gravitation. Personality characteristics constitute one of the most significant variables influencing the encoding process because the personal meaning a student infuses information with affects how information is encoded, retrieved, or related by tagging information as either pertinent or irrelevant to current or novel situations, thereby facilitating transfer in the process.

Fifth Principle of Transfer: Nature and Function of Transfer

Learners must grasp the nature and function of transfer (Haskell, 2001). Learners must understand what transfer of learning is and how it works because transfer influences all learning, memory, problem solving, and cognitive processes. An evolutionary lag is said to exist between the current processing needs of the Information Age and our brain's development; this evolutionary lag may be shortened through transfer of learning. Transfer is conducive to all levels of learning, ranging from low-level skills to high-level theoretical thinking. As a process, it enables our past knowledge to impact our current learning. For this to occur, transfer requires analogical reasoning, arguably, the fundamental mechanism in learning. Transfer, therefore, is responsible for our creativity and learning itself.

Physics application. While studying about gravity, students and teachers should be familiar with Haskell's (2001) two taxonomies of transfer: levels (degrees) of transfer and kinds (types) of transfer. Both taxonomies inform us when, how, and where transfer occurs. The first taxonomy reflects six precise degrees of similarity: nonspecific transfer, application transfer, context transfer, near transfer, far transfer, and displacement or creative transfer. The second taxonomy implies that types of transfer may be classified into either of two categories: (1) what type of knowledge is the transfer predicated on? or (2) what specific kind of transfer is being sought? Haskell identifies five types of knowledge: declarative, procedural, strategic, conditional, and theoretical and 14 kinds of transfer: content-to-content, procedural-to-procedural, declarative-to-procedural, procedural-to-declarative, strategic, conditional, theoretical, general or nonspecific, literal, vertical, lateral, reverse, proportional, and relational. Haskell asserts that, theoretically, it is frequently difficult in practice to separate types of knowledge and that we should not infer that any of the fourteen specific kinds of transfer are inevitably mutually exclusive.

Sixth Principle of Transfer: Orientation to Think and Encode in Transfer Terms

Transfer is dependent upon learners' orientation to think and encode their learning in transfer terms because significant transfer is never automatically assured (Haskell, 2001). The retrieval of information is strongly influenced by the method employed to encode or store it. A spirit of transfer provides a learner with an inquiring disposition to obtain knowledge and to develop a sense of the structure of the problem or of the big picture in order to identify relevant information in situations that are either problematic or unfamiliar. Information, therefore, is infused with meaning, and meaning makes it possible for information to be transformed into transferable knowledge (Bereiter, 1995).

Physics application**.** Brell (1990) states that teaching students how to transfer learning (e.g., principles or concepts of gravitation) entails not only a transmission of thinking skills, knowledge, and strategies (though these are important) but also, and preeminently, the fostering of an inquiring disposition from the outset. Moreover, unless such dispositions are cultivated and sustained on a long-term basis, transfer of content area knowledge is rendered illusory.

Seventh Principle of Transfer: Cultures of Transfer

Learning environments presuppose the creation of cultures of transfer (Haskell, 2001). Transfer of learning should be viewed as a sociocultural or collective process because the spirit of transfer and the mechanisms of transfer are shaped by the various systems--social, group, and organizational--in which they occur. Theoretically, therefore, there exist infinite transfer contexts and cultures, contingent upon how significant our assessment of the similarity between situations is perceived.

Physics application. Teachers should employ interdisciplinary curricular and integrative learning as opportunities to enhance transfer of learning in the classroom. Students should be taught how to apply the principles and concepts that they have learned about gravitation to topics in other disciplines: chemistry (e.g., subatomic particles, weak force, strong force), mathematics (e.g., algebraic equations, trigonometric equations, calculus: differentiation), social sciences (e.g., the history of ideas, the evolution of economic/psychological/anthropological theories), English (e.g., an essay comparing and contrasting Newton’s and Einstein’s systems of gravitational theory), music/art (e.g., designing a musical production that would incorporate sound and graphics to reflect the producers’ idea of the role of gravity in the universe). More importantly, students also should be shown how to relate what they learned about gravitation in school to situations and contexts that they typically encounter in everyday life (e.g., Einstein’s principle of equivalence [riding an elevator], mass and weight [using specific scales], gravity and altitude, gravity and force, orbiting satellites/interplanetary objects, frame-of-reference topics [moon phases], three-dimensional concepts, vectors’ role in meteorology or in airplane/automobile trips, G-forces [fighter pilots and astronauts]).

Eighth Principle of Transfer: The Theory Underlying the Transfer Area

It is critical that learners grasp the theory undergirding the transfer area in question (Haskell, 2001). Haskell considers theoretical knowledge to be as important as declarative knowledge because both transfer of learning and theoretical knowledge are interdependent. This interdependence is made possible because theoretical knowledge simultaneously supplies us with a standard for guiding our transfer and a frame of reference for restraining runaway transfer. Theoretical knowledge, therefore, is an efficient manager because each time we transfer knowledge we are provided with reinforcing feedback to obtain more (Tan, 1992).

According to Haskell (2001), it is imperative that teachers initially identify students’ misconceptions before commencing to teach for transfer because, if transfer is to occur, instruction must deal with the current status of the cognitive system it is hoping to influence.

Physics application. Teachers, initially, should ascertain students' current misconceptions about gravity prior to discussing its theoretical aspects in-depth. The following categories are amongst the most commonly held misconceptions about gravity: mass and weight, gravity as a force, implicit vector features, mass and rate of descent, strength of gravity and altitude, absence of gravity in space, rotation as a cause of gravity, three-dimensional concepts, frame-of-reference topics, gravity and inertia, curved space fallacies, volume and density, and velocity and acceleration.

Once students' perceived misconceptions have been identified and resolved, the teacher should then embark on a discussion of the theoretical nature of gravitation—most notably, the following systems: Isaac Newton's, Albert Einstein's, M-theory, Super gravity Theory, and Superstring Theory. A focus on Newton's contributions might include his 3 Laws of Motion and his Law of Universal Gravitation. A focus on Einstein's contributions might include his Special Theory of Relativity ($E = MC^2$ and the speed of light), the General Theory of Relativity (his Equivalence Principle, geodesics, curvatures of space-time [curvature of space and time dilation, matter and energy curving space and time]). Newton and Einstein's treatments of gravity could be compared and contrasted. Finally, a focus on M-theory, Supergravity Theory, and Superstring Theory might include a discussion of the latest attempts to unify quantum theory and the theory of general relativity into a Theory of Everything.

Ninth Principle of Transfer: Drill and Practice

Learners' investment of time in drill and practice is a prerequisite of transfer (Haskell, 2001). Practice is imperative because failures of transfer are frequently due to the insufficient practice and mastery of the original information before attempting transfer. Regardless of the setting, expertise requires sufficient practice to adequately encode material to be learned; otherwise, transfer fails. All practice, however, is not indistinguishable. Accordingly, the question arises: What, then, constitutes appropriate practice? The nature of practice, for instance, cannot be adequately defined as merely repetition per se. Rather, repetitive practice must be specified, based on its purpose. For example, Will rote drill be employed to automatize an activity? Or, will practice be used to produce improvement of learning?

Physics application. When teaching the concepts and principles of gravitation and when assigning problems that focus on the application of gravity, teachers must prudently determine which fundamental approach to processing information and which type of practice and skills students should use to master the original information and especially to maximize the chances of achieving far transfer.

Tenth Principle of Transfer: Incubation Time

Our culture of expectations teaches us, regrettably, to expect, if not to demand, instantaneous success regarding whatever we do (Haskell, 2001). Unfortunately, these expectations frequently lead our students to quit attempting to transfer. Incubation time is a requirement for expertise and significant transfer to occur because it is time away from our conscious attempts to identify similarities or analogies, while providing new insights or approaches at the subconscious level.

Physics application. While studying about gravitation, teachers should remind students that they need incubation time initially for assimilating and accommodating knowledge and for solving assigned problems; then, they can focus on transferring what they have learned. Our ability to process information at the conscious level is much more limited than our ability to subconsciously process information. In addition, these two information-processing approaches lead to near transfer and far transfer, respectively.

Eleventh Principle of Transfer: Reading and Observing Exemplary works of Transfer

It is crucial that learners read and observe exemplary works of transfer thinking (Haskell, 2001). Reading the works or biographies of great exemplars of transfer thinking is important because doing so will provide readers with first-hand knowledge of how critical a role analogical reasoning has played in history’s greatest discoveries, inventions, and innovations.

Physics application. Reading the works of people who exemplify transfer thinking, while studying about the theory of gravitation, will significantly benefit students’ understanding of transfer. For example, systems thinkers (e.g., Isaac Newton, Charles Darwin, Albert Einstein, cosmologists, and ecologists) rely heavily on analogical reasoning and transfer thinking while developing their extensive theories. Reading about descriptions of scientific discoveries (e.g., planets, penicillin, X-rays, radium, and DNA) reminds us that only a “prepared mind” can perceive what would otherwise go unnoticed. Inventions and innovations (e.g., the airplane, computer chips, radar, and surgical procedures) have revolutionized our world, thanks to significant transfer skills. Artists (e.g., poets, composers, sculptors, and dancers), too, are classic examples of people who have truly mastered transfer thinking and analogical reasoning.

Conclusions

Research indicates that transfer undergirds all aspects of learning, thinking, problem solving, and memory (Mayer, 1987). Although the transfer of the aforementioned processes is integral to teachers' expectations and aspirations, many students, after having completed their education, fail to apply what they learned in school to real life situations. Transfer of learning, consequently, persists as one of the most vexing, paradoxical problems in our classrooms (Bevevino, Dengel, & Adams, 1999). In addressing this pivotal issue, Haskell (2001) proposed a theoretical framework for achieving general transfer that consists of 11 fundamental learning and instructional principles that converge on the following topics: primary knowledge base, peripheral knowledge, the history of the transfer area(s), motivation, the nature and function of transfer, orientation to think and encode in transfer terms, cultures of transfer, the theory underlying the transfer area, drill and practice, incubation time, and reading and observing exemplary works of transfer.

In view of the aforementioned 11 learning and instructional principles, Haskell's (2001) proposed theoretical framework for achieving general transfer offers students and teachers an opportunity for enhancing content area reading instruction for K-12 learners. In addition, given how pervasive and central a role transfer of learning plays in our daily lives and the demands of The No Child Left Behind Act (2001), teachers and students will be better prepared to meet the demands and challenges of state standards, benchmarks, and grade level expectations. Finally, it behooves educators to continue to glean the research that has been conducted on transfer of learning, if our nation is to be globally competitive in the 21st century because our highest intellectual achievements, advances, and successes are predicated on analogical thinking: the essence of transfer.

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