

Relationship Between Cognitive and Psychomotor Development

Piaget in the Gym

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In developing curriculae to best teach children, it is apparent that a good working knowledge of all stages of development is important. Development of the child will then be facilitated at every level. Physical educators need to understand cognitive development and how it relates to psychomotor development, thus enabling them to develop appropriate lesson plans and methods of instruction.

Piagetian theory is an organismic theory which claims the child's intellectual development is influenced and in essence determined by interactions with the environment. Piaget was considered a Constructionist because he believed children construct knowledge using internal structures acting on their environment. An interdisciplinary approach to explain development and learning may help physical education teachers understand the child as a whole. A working knowledge of child development with particular emphasis in motor control forms the basis for intelligently teaching motor skills to children (Robertson and Halverson, 1984).

Schemes

A scheme has been defined as an organized pattern of behavior (Ginsberg & Opper, 1979). Piaget's concept of scheme could be operational, sensorimotor, or a combination of the two (Kerr, 1982). Schemes may represent innate or outward behaviors and may also designate the essence of an indi-

vidual's behavior. Behavior may be similar, but parameters may be somewhat variable.

Schemes have been studied with respect to perception, intelligence, and motor control. Schemes are created as the individual interacts with the environment. As they are repeated, schemes are internalized and generalized. Operations are internalized actions of the mind such as classification and reversibility (Ginsberg & Opper, 1979).

Assimilation and accommodation are processes that help develop schemes (Ginsberg & Opper, 1979). As the child assimilates an event in the environment, structure is given to that environment. Accommodation occurs as change is made in structure based on what is actually known from the experience. Without accommodating, the child's view of the world would never evolve (Ginsberg & Opper, 1979).

Equilibration

An individual will eventually move towards a balance in his existing structure and in the demands of the world around him. This is the process of equilibration. Theoretically, this process is the result of assimilation and accommodation. Piaget felt this was a very important concept. The individual had to be able to accommodate the world around him. Piaget called the impetus for progression through these stages an equilibration process (Ginsberg & Opper, 1979). More complicated states were reached as the individual aged.

Progression through the stages, an equilibration process, is sufficiently developed

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when the organism exerts little effort either to accommodate structures to reality or assimilate events into them (Ginsberg & Oppen, 1979). As the child interacts with the environment new ideas, new actions, and new thoughts are formed. These processes allow the child to grow and achieve higher cognitive states. Intellectual development may be visualized as a continuous spiraling process with equilibration being the driving force behind the adaptation of the individual to the environment (Labinowicz, 1980). As equilibration occurs, there are periods of stability followed by periods of instability during the transition between stages. This concept relates to chaos in the dynamical system approach. The organism is seen to experience these same periods of stability and instability as degrees of freedom of the task are experienced. The organism is driven forward by its self-organizing characteristics (Ulrich, 1989).

Adaptation and organization are concepts that are interwoven, and structures and schemes are necessary for individuals to achieve equilibration. As the individual progresses through life, functions remain the same, but structures vary and appear in a fairly regular sequence (Ginsberg & Oppen, 1979). Cognitive development proceeds through a series of stages, each characterized by a different scheme or structure, motoric ability, and type of interaction between the individual and the environment.

Cognitive developmental stages developed by Piaget are as follows: (a) sensorimotor period, (b) pre-operational period, (c) concrete operational period, and (d) formal operational period. The order does not vary, but the rate of progression for each individual may vary.

Schmidt's Schema Theory

Schmidt's schema theory of motor learning evolved as a result of existing theories. Schmidt tried to look at current theories and convey a theory that would include the

best of current theory and proceed to help explain motor learning (Kerr, 1982). Schema theory is based heavily on knowledge of memory and motor control concepts in conjunction with ideas about learning processes in an attempt to explain the learning of rapid and slower movements (Schmidt, 1975). Schmidt used the term *schema* to represent a rule or set of rules that serves to provide the basis for a decision. These are developed by abstracting important pieces of information from related experiences and combining them (Magill, 1993). There are three components to the schema theory: (a) generalized motor pattern, (b) recall schema, and (c) recognition schema.

Generalized Motor Pattern

A generalized motor pattern comprises the foundation of schema theory. A *generalized* motor program is an abstract memory structure that, when activated, causes movement to occur (Shapiro & Schmidt, 1982). Schema theory focuses on the processes that occur after the generalized motor program has been selected instead of the selection of the motor pattern. This is where recall and recognition play significant parts. They are required to execute each program and achieve the desired outcomes. These memory states have also been referred to as rules and schemas which serve to provide the basis for a decision (Magill, 1985). Both schemas are rules whose strengths are positive functions of the number of practice trials and the variability of practice (Schmidt, 1975).

Recall and Recognition

According to Schmidt (1975), four things must be stored after each attempt to learn a goal-oriented movement. These four sources of information are: (a) initial conditions, (b) response specifications or motor program parameters, (c) sensory consequences, and (d) response outcomes.

Initial conditions are made up of information received from various receptors prior to response, such as visual and auditory information about the state of the environment or proprioceptive information about the position of the body in space (Schmidt, 1975). Response specifications or motor program parameters specify important elements of movements such as speed and force before the program is fired off in the central nervous system (Schmidt, 1975).

Sensory consequences consist of actual feedback stimuli from all senses and proprioceptors. These sensory consequences are an exact copy of afferent (incoming) information provided on response. Response outcomes are the actual outcomes. Outcome information comes from feedback the subject receives after the movement is completed and consists of knowledge of results and internal subjective reinforcement that can be obtained from other sources of feedback. A subject without any feedback information internally or externally does not have outcome information to store (Schmidt, 1975).

These four sources of information are stored together after the movement is completed. An abstract motor schema is developed from the information about the relationship among these four sources. A rule is postulated which enables the learner to generate a generalized motor program for any specific situation without having to store the individual motor program (Kerr, 1982). Through comparison of actual and expected consequences, error signals are generated. Recognition schema will label any discrepancy as an error. Error signals may be seen as a result of comparison of expected and actual outcomes or as a labeled signal corrected into reportable form.

Schmidt also looked at how one executes a novel task (Schmidt, 1975). The probability of exhibiting a movement for the first time is increased through increased amounts of practice and a variety of experiences involving the skill. It would be difficult to prac-

tice all movements of a skill; however, if enough time is spent in a variety of practice situations, there will be more general rules for performing that task.

Integration of Theories

The basic and most important similarity between the theories of Piaget and Schmidt is that both develop schemes from abstractions of past experiences. Schmidt's theory enables us to fit motor skill learning into the overall developmental model of Piaget, both in terms of specific skill acquisition and game strategies (Kerr, 1982). Schmidt (1975) suggested the motor schema guide is a generalized motor pattern which serves as the basic unit of motor control. The schema theory is more concerned with the processes after the motor program has been selected. Operational thought could be utilized for the determination of what movement pattern to select. Operational thought is also required for developing strategies, as well as being involved in predetermined motor skills in refining and combining at the concrete or formal operations levels.

Piaget's assimilation and accommodation would occur as initial conditions are experienced for skill development. During open and closed skills, children rely on recognition and motor recall schema to accommodate cognitively and motorically to the changes in the environment. Assimilation and recall schema may be similar in their processes. Motor recognition may be analogous to accommodation. This would happen as the organism would adapt to the most desired goal by evaluating and reorganizing because of the environment. Evidence to support motor recall and recognition has been lacking due to the fact they both exhibit the same process of accommodation. Through Piaget's cognitive stages of development, Schmidt's motor recall may find help. Children are seen to express different levels of motoric proficiency as they grow. As children grow, they evolve and reach

higher levels of cognition. Acquiring more complex skills would involve higher cognitive structures, which would explain the inability of young children to acquire complex motor skills.

In relation to learning a novel task, Piaget's theory stresses that current cognitive structures and new experiences interact to arouse interest and stimulate subsequent development of understanding (Ginsberg & Opper, 1979). Piaget felt that the child's interest is best maintained if the task is moderately new or novel. This allows the child to assimilate the activity with some effect. Schmidt's work in the area shares the same idea. The target skill one is trying to teach should be presented in different initial conditions and should be somewhat novel in order to hold interest and increase practice time. According to Piaget, as conflicts are presented to the child through novel tasks, the reorganization of cognitive structures results in development.

Themes of variety and progression are present in cognitive and motor schema. In cognitive development these themes result from the process of assimilation and accommodation. In Schmidt's motor learning, they are the result of motor recall and recognition. The idea of a broad base of information is reduced and represented as abstract concepts or generalized motor programs.

Dynamical systems approach has become very appealing because of the questions it may answer. For this discussion, it can be seen that dynamical systems relates well to Piagetian theory. The process of assimilating and accommodating would be equivalent to the organism interacting with the environment and its systems, working together to achieve coordination of the degrees of freedom of the task (Ulrich, 1989). Both Piaget and Schmidt consider interaction of the individual with the environment to be of great importance, and that periods of stability and instability (equilibration/chaos) are

present and necessary to move on to higher task levels.

Dynamical systems appears to answer some questions schema theory could not. Schema theory explains only after the motor pattern is selected. It does nothing to explain how or why that motor pattern is selected. The storage issue has never been fully explained and has added to the vacuum that has existed in the total acceptance of the schema theory. Dynamical systems looks at how the movement is chosen as a result of interacting with the environment. Actions are self-organized and softly assembled, rather than being hard wired in a particular system (Ulrich, 1989). Organization inherent in coordinative structures dissipates the degrees of freedom by grouping muscles together and by using forces generated by the moving systems as information contributing to constraint of the action (Krulger, Kelso & Turvey, 1982).

Applying this to teaching will ensure proper sequencing and appropriate lessons for skill development. First if a teacher understands that children learn best from interaction with their environment, then they need to provide for practice time in the lesson appropriate for the skill being learned. There is no verbal transmission of the skill from the teacher to the students. Appropriate time must be spent repeating the skill to acquire coordination to perform successfully. Novel tasks have been shown to hold students interest longer. The teacher should choose many different activities to provide practice for the students. Even simple variations will help keep them on task and provide meaningful practice.

Secondly the teacher should have an understanding of the children's cognitive level in order to give them appropriate instruction. If they do not understand what you want them to do, skill learning will be slow or not occur. Instruction should be kept short and then key cues or points emphasized throughout the lesson. Stop and review fre-

quently so the students are kept on task and reminded of correct skill performance. Thirdly the teacher should recognize that there are periods of equilibration/chaos as children acquire coordination of motor skills. Lessons should be success oriented so that as children pass through these stages they will continue to be motivated and enjoy activities as they learn their motor skills. Equipment needs also to match the students ability levels. This will enable them to practice at there level and be successful.

Understanding these developmental theories has great implications for how children learn and how we teach. Parallels should be drawn between theories and points that support each other, and should be reflected upon for use in teaching. We need a total understanding of child development to facilitate learning in children today. This will enable the teacher to provide the most appropriate environments for learning as children pass through their stages of development.

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