The Piagetian Intelligence Model and the Learning Cycle

Jean Piaget was a Swiss psychologist whose work in the area of cognitive development led to the development of an intelligence model that attempts to explain how cognitive development proceeds and how learning takes place. This paper will discuss various aspects of this model and how they relate to the learning cycles used in secondary science teaching. There are two main aspects to this model: mental functioning and the quality of thought. We will address the quality of thought aspect first.

Quality of Thought

People take in data from their experiences with the world. The experiences which affect a person's interpretation of stimuli are content. Content is not meaningful to a person until it has been transformed by that person's mental structures. The data a person acquires through experience, however, cannot always be transformed by his or her mental structures into meaning. This inability of a person to transform certain experiences into meaning leads to the quality of thought aspect of the model.

Developmental Periods and Factors

Research has shown that people may display four sequential developmental periods in which their quality of thought is different. Four factors which lead from one period to the next have been identified. They are maturation, experiences, social interaction, and disequilibration. Maturation is physiological development and growth. The other three factors are easily influenced by the schools. Diverse and rich experiences coupled with many opportunities for conversation and cooperation will help a child move through the periods. Disequilibration can also be provided in the classroom - this will be discussed further when the mental functioning aspect of the intelligence model is presented. Before that, the four developmental periods should be discussed.

The Sensory-Motor Period

The first period is called sensory-motor. A person displays this quality of thought until they are approximately eighteen months old. (The ages given for the developmental periods are generalities; individuals display considerable variation.) During this period an infant will develop schemes - actions that can be performed and repeated. Behavior skills are acquired and coordinated, while verbal and cognitive skills show minimal development and poor coordination.

The Pre-Operational Period

The next developmental period is called pre-operational. It typically lasts until a person is about seven years old. Individuals at this stage internalize their sensorimotor schemes in the form of cognitive schemes such as imagery and thought. For example, puzzle-solving shifts from trial-and-error methods to image-based ones supported by memories of previous behavior. Children at this stage cannot conserve invariant aspects of objects in their minds, do not see states in a transformation, display irreversible thinking and transductive reasoning, and are quite egocentric.

The Concrete and Formal Operations Periods

The final two developmental periods are of particular interest to secondary science educators. The period of concrete operations develops from ages seven to twelve. Some people never enter the period of formal operations which follows this stage. Thus, many students in a classroom may not be formal thinkers but totally or partially concrete. A person who exhibits the concrete operational quality of thought can conserve the invariant aspects of objects such as length, volume, and number. Concrete thinkers display classification skills, seriation, negation, identity, and compensation. The most important aspect of concrete thinking, however, is that mental operations can be carried out only if those operations are performed with data from actual experiences. Concrete thinkers are limited by what they can actually experience. Renner (1987) states, "They cannot...form theories because they cannot think about that which is not."

To effectively teach concrete-operational students, learning cycles must deal with concepts that can be learned through direct experience. Because almost always some of the students will be totally or partially concrete, secondary school science courses should deal with concrete concepts. Formal concepts, which cannot be learned through direct experience, will only be learned by students who are formal operational. Formal students can think in symbolic terms and about abstract content. They can reason with verbally expressed hypotheses, whereas concrete students cannot. Students who are formal operational can learn both concrete and formal concepts, while students who are concrete operational can only learn concrete concepts.

Therefore, a physics teacher with both concrete and formal thinkers should not expect everyone to fully understand a learning cycle on electromagnetic waves because that is a formal concept. Similarly a junior high science teacher should not expect that most of his or her students will understand a learning cycle about the genetic code, because many junior high students are concrete operational and the genetic code is a formal concept.

Mental Functioning

The other primary aspect of the Piagetian model of intelligence is that of mental functioning. It explains how a person learns, no matter what developmental period he or she is at. Mental functioning is again divided into four sequential steps: assimilation, disequilibrium,

accommodation, and organization. The learning cycle is derived from these four steps of mental functioning.

Assimilation

The Exploration phase of the learning cycle is directly related to the first step in mental functioning, assimilation. A person assimilates by taking in information and filtering it through his or her mental structures. Assimilation is the mental activity of taking ideas from experience. If the information taken in fits into existing mental structures, a person is in equilibrium. If the information does not fit, a person is disequilibrated, the next step in learning. Thus, a student who already understands Ohm's Law will assimilate during the Exploration phase of a learning cycle on Ohm's Law but will not be disequilibrated.

Disequilibration

The next step in the mental functioning aspect of the intelligence model is also one of the four factors which guide a person through the developmental periods of the quality of thought. Disequilibration occurs when a person is uncertain of the meaning of some data - when they experience something which doesn't fit their content or mental structures. The learning cycle attempts to cause disequilibration in students by exposing them to data in the Exploration phase that they cannot explain. Piaget's theory states that people will engage in adaptational behavior so as to reequilibrate themselves. This desired reequilibration occurs when a person accommodates.

Accommodation

The Conceptual Invention phase of the learning cycle is when students are expected to accommodate to new ideas. The students are expected to redefine, change, or invent mental structures at this point. Accommodation will usually occur during the class discussion of the data. When students accommodate, they "invent" a new concept.

Organization

The last step in mental functioning is organization, when a person relates their new or changed mental structures to other ones. A person is putting "thought in accord with thought" at this point. The Expansion of the Idea phase of the learning cycle is derived from this step. By being exposed to a concept in different situations, students are led to organize their mental structures that relate to that concept.

Conclusion

The intelligence model of Jean Piaget is important in understanding why the learning cycle is organized as it is, and how it should be applied. The quality of thought aspect of the model can be used to identify concrete and formal concepts and leamers. Thus concrete concepts can be matched with concrete learners and formal learners can be exposed to both concrete and formal concepts. The mental functioning aspect of the model is the theory behind the phases of the learning cycle. By careful application of the intelligence model in the classroom, a science teacher can effectively use the leaming cycle approach to instruction.

References

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