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Introduction

There are selected issues which need analysis and relevant solutions in the science curriculum. Teachers, principals and supervisors need to become thoroughly familiar with these issues and attempt to achieve a viable synthesis.

Inductive Versus Deductive Learning

There are science educators who place a high value upon pupils achieving facts, concepts and generalizations inductively. The teacher then needs to provide adequate readiness experiences for learners to proceed inductively in achieving relevant understanding. These readiness experiences include:

(a) pupils having an adequate knowledge base.
(b) pupils intrinsically being motivated to achieve new objectives.
(c) pupils desiring to learn relevant content by discovery methods.

To have learners achieve in an inductive manner, among other things, the teacher needs to be a poser of good, sequential questions. Thus, pupils may be guided to achieve significant tentative conclusions. A variety of materials (concrete, semi-concrete, as well as abstract) should be inherent in these teaching-learning situations.

Toward the other end of the continuum, the competent science teacher may secure pupil interest to achieve relevant objectives in a deductive manner. Thus, the teacher, using a variety of activities, may explain content clearly and concisely to pupils. Ideas expressed move from the teacher to the pupil. The focal point is upon the pupil achieveing subject matter learnings presented by the teacher. Ultimately, the pupil will *utilize* that which has been taught.

No doubt, many science teachers will find a rational balance between inductive versus deductive methods of teaching science. However, a major problem still persists in terms of the following question: Which method of teaching science should be paramount — inductive or deductive?

Rewarding Pupil Behavior

How should pupils be rewarded for achieving at an adequate level on an individual basis? Rudolph Dreikurs would recommend that pupils be praised for effort put forth in learning. Thus, demonstrated, observable achievement by pupils should not receive major emphasis in rewarding

pupils, according to Dreikurs. Rather, praise the involved learner for trying and working. Thus, in an ongoing science unit of study, if pupils individually are putting forth much effort in performing experiments, using diverse audio-visual materials, and reading to get needed information to solve a problem, these deeds and acts need to be praised.

B.F. Skinner, on the other hand, believes that demonstrated, objective results, alone should be rewarded. Effort alone, does not show ultimate achievement. Rather the quality of written conclusions, from experimentation or from the utilization of selected audio-visual materials, or from reading, should be rewarded. The written conclusions provide observable evidence in terms of pupils having/not having achieved at an adequate level. B.F. Skinner might even emphasize the use of programmed materials in science to ensure success (reinforcement in learning). As one model in programmed learning, a pupil may read a sentence or more, view a related illustration, answer a completion item, and check the personal response with that provided by a programmer. A correct answer is rewarding. An incorrect response involves self-correction on the part of the involved pupil; the learner compares his/her answer with that given by the programmer. In either situation, if the pupil is correct or incorrect, he/she is still ready for the next sequential item in linear programming. The same procedures sequentially may be followed again and again in learning when utilizing programmed materials — read, respond, and check; read, respond, and check. The reward is being successful within the framework of each sequential step of learning.

Jerome Bruner, psychologist from Harvard University, would say that learning is its own reward. Facts, concepts, and generalizations that pupils are to attain need to be presented in a manner in which pupils learn by discovery. Enactive (manipulative materials), iconic (semi-concrete experiences providing mental images), and symbolic activities (abstract experiences) provide the framework for inductive learning. The excitement and interest in learning by discovery provides needed motivation for pupils to achieve and acquire.

In rewarding pupils for improved achievement, the teacher may then praise positive efforts (Dreikurs model), utilize extrinsic rewards (Skinner model of reinforcement), and/or assist pupils to preceive intrinsic values of learning (Jerome Bruner model).

Teacher Determined Versus Pupil Input in Learning

Who should select objectives for pupils to achieve? Behaviorists, in general, would say that the classroom teacher needs to determine specific sequential ends for pupils to achieve. Thus, on an individual basis, each pupil may attain these ordered ends sequentially based on his/her optimal level of achievement. The teacher may also choose learning experiences and means of assessing learner achievement. If a pupil has demonstrated achievement of a specific objective, he/she may then move on to the next ordered end.

Toward the other end of the continuum, within a flexibly developed rich learning environment as developed by the teacher, a pupil may select which learning center and which task to complete. Thus, the involved pupil orders his/her own learning experiences. Not all tasks may be completed at the diverse centers by any one pupil. If this were possible, the involved learner would only select the order of learning activities, but not which activities to complete and which to omit. Teacher-pupil planning may be utilized to determine materials and activities at selected centers. A humane learning environment may then be in evidence.

Humanism, as a psychology of learning, emphasizes that pupils develop:

1. proficiency in the making of decisions.
2. adequately in the affective dimension. Thus, learners have ample opportunities to achieve positive attitudes when selecting the ends and means of learning.
3. in the direction of achieving self-realization. Hopefully the learner will become what he/she desires as an ultimate objective.
4. positive feelings toward being secure and having status in a group.

In Conclusion

There are selected issues which need resolving in the science curriculum. These include, among others:

1. How much inductive versus deductive learning should be emphasized in teaching-learning situations?
2. How should pupils be rewarded for improved performance in the learning arena?
3. Who should be involved in selecting objectives, learning activities, and evaluation procedures for pupils in the school/class setting?

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"Science is built of facts the way a house is built of bricks . . . but, an accumulation of facts is no more science than a pile of bricks is a house."

Jules Henri Poincare