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The Use of Transactional Analysis with Inquiry Methods in Physics Teaching

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You're OK and So Is Physics

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How does the nonscience student feel in your physics class? Does your classroom environment help him feel like a winner or a loser? Most likely this student is not able to understand the logical-mathematical structure of physics.[1,2] Furthermore, his inability to handle mathematical concepts has probably caused him to develop feelings of inadequacy about himself and formal science courses. In attempting to provide a learning experience in physics for a prospective elementary school teacher, we discovered that we had to consider not only the physics content but also the student's self-image. This latter aspect of our experience led us to develop a program that uses the tools of transactional analysis[3] to assist the student in improving his understanding of himself and to enable him to develop more positive attitudes about himself and physics.

We now offer a course that combines an inquiry approach to physics with elementary school science teaching methods and transactional analysis. Our course carries three semester credits in elementary science methods and three semester credits in physics, a total of nine contact hours per week. In previous interim courses the very positive response we have had from our students, i.e., the excitement in discovering some real physics for themselves, and their decision to use the tools of transactional analysis to say "OK" to themselves and physics, leads us to believe that our course can serve as a useful model for other introductory college science courses.

The Three Ingredients

A. Transactional Analysis: Transactional Analysis (TA) was introduced as a general theory of human behavior in 1957. It is familiar to many through the best selling books *Games People Play* by Eric Berne[3] and *I'm OK, You're OK* by Thomas Harris[4] and is widely used in group and family therapy. TA has a scientific basis, a precise unit of observation, and a clear conceptual framework. Many of its terms are colloquial, e.g., the simple model of a person as composed of three parts (ego states), Parent, Adult, and Child. Hence TA is easy to understand and apply, but it is very powerful in bringing insight into the communicative intent of all human behavior. Transactional analysis offers the teacher a way of describing, classifying, analyzing, and improving the interchange of information for decision making, reality test-

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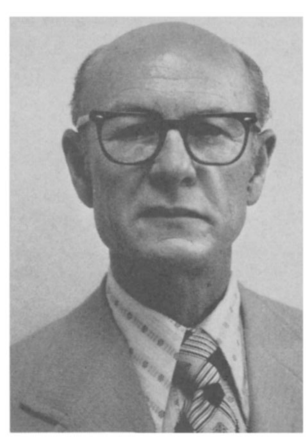

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ing, probability estimating, and self-awareness. Transactional analysis succeeds by focusing on understanding the OK self as a vehicle for improvement of communications with the OK other.

The foundation of transactional analysis is the model of a human being that assumes everyone has three parts within himself: a Parent, an Adult, and a Child.

> These parts are known technically as *ego states*. The Parent in you feels and behaves in ways your mother or father, or whoever raised you, did. Your Parent can be critical or helping, or both. The Adult is the part of you that figures things out by looking at the facts. Your Adult is your computer, the part that uses facts to make decisions. The Child in you is what you were when you were little. Your Child has the same feelings and ways of behaving you had when you were very young. Your Child can be natural, i.e., act on his own, not under the influence of your internal Parent; or he can be adapted so as to please your internal Parent. Each of your three parts has its own ways of feeling and behaving.
>
> Your three ego states are like voices in you. The Parent is the one who says things like, "You must," "You should," "You should not," or "Don't." Slogans like, "If you want something done right, do it yourself," "A woman's place is in the home," "Boys will be boys," "You can't win," etc., are the Parent. Your Child may say, "I want what I want when I want it," or "Try and make me." The Adult in you prefers to operate on facts, not feelings. Your Adult says things like, "Here is how this works." Often the three parts of you disagree with one another.[5]

One of the purposes of introducing TA to prospective teachers is to enable them to get all three parts of themselves working well together.

The word transaction means an exchange between two people and is used to describe how people talk or act with each other. When you say "Hello" to someone, and he says "Hello" back, the exchange of hellos is called a transaction, a bit of social business. The Parent, Adult, or Child in the other person will be answering the Parent, Adult, or Child in you. All conversations are a series of transactions, one exchange after another. These exchanges can be Adult to Adult, Adult to Child, Adult to Parent, Parent to Parent, Parent to Adult, Parent to Child, Child to Parent, Child to Adult, or Child to Child. Shown in Fig. 1 are two diagrams of simple transactions. The lines with arrows show the direction of the communication. If the lines in the diagram are parallel, the transaction is straightforward and the communication is unbroken. However, if the communication lines in such a diagram become crossed, communication breaks down.

The driving force behind communication, according to TA, is the hunger of every person for strokes, for any act on the part of another person that implies a recognition that you exist.[6] Strokes can be given in the form of actual physical touch or by some symbolic form of recognition such as a look, a word, a gesture, or any act that says "I know you are there." Everyone needs to get and to give some kind of stroking, pleasant or unpleasant. A child would rather be spanked than completely ignored. A stroke that helps you feel you are OK is called a *positive stroke*. One that tells you you are not OK is a *negative stroke*. Loving is positive stroking. Hating is negative stroking.

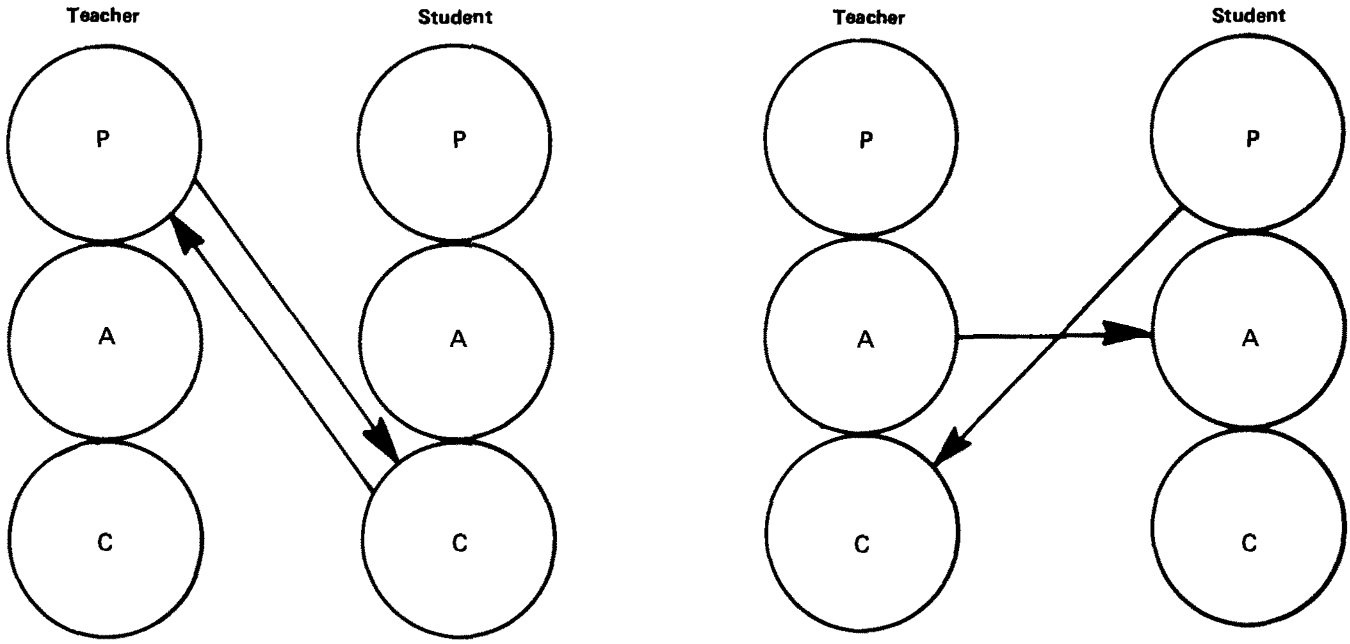
The kind of strokes you give and get depends upon how the Child in you feels about yourself and about others. How you feel about yourself and others is called a basic life position. Of the four possible life positions, for the prospective science teacher, only two are important.

(1) *I'm OK; you're OK*. This is the healthy position, the "get-on-with-it," winner's position.

(2) *I'm not OK; you're OK*. This is the position when the Child within a person feels unworthy, uncertain, or frightened. It is a "get-away from-it" position of withdrawing, running away, procrastinating, or complying.

This latter position is the almost universal position of elementary education majors when they relate to science. Most of them take a minimal science course in college and what they feel about science is based upon precollege science experiences, often taught to them by teachers who felt NOT OK about science. Therefore, a beginning step toward improving the quality of science teaching in elementary schools is to enable teachers to develop an awareness of their own feelings about science and help them plug in their Adult so that they can decide to be OK in their teaching of science. Then the science teacher can help students feel OK about science and their total learning experiences.[7]

The first few class periods introduce the basic transactional analysis model to the students. They develop a working understanding of TA through classroom discussions, reading assignments, and homework questionnaires, e.g., make a list of what you do for fun, or make a list of the injunctions you commonly use or heard your parents use.[8] Their understanding of TA is practicalized through a variety of small group activities, including role playing of various ego state transactions and games. To assist them in understanding themselves and empathizing with their future pupils they are put in some stressful situations. For example, on the first day of class a difficult mathematics pretest is given. This examines their basic skills and "hooks their NOT OK feelings." At the end of the class they are given an evaluation form and asked to write down their feelings about the pretest. These evaluations are discussed in later class sessions. Several laboratory experiments give them an opportunity to experience frustration with Mother Nature and her stubbornness. Later group discussion assists the students in understanding their behavior. Some students are secretly selected to play dominant Parent roles during the experimental activities. They use strict "Do it this way" language with their peers. After a short time the various groups are stopped and their feelings about the group interactions are discussed. The TA model is used to analyze



Student: "I don't ever know what to do first."

Teacher: "You must take one of the balls, hold it 1 meter above the floor, drop it and measure how high it bounces."

Parallel Transactions

Communication Continues

Teacher: "Here are a variety of balls. Let us examine the properties of bouncing balls."

Student: "Aw, that's easy. Everybody knows that the most elastic ball always bounces the highest."

Crossed Transactions

Communication Ceases

Fig. 1. *Diagrams of two transactions.*

their interactions. Several TA tools for "hooking the Adult" and "affirming the OK" are discussed and practiced.[8] Many classroom spontaneous transactions are analyzed. Each person discovers the importance of his basic life position in his transactions with others. He is encouraged to address his NOT OK feelings openly and develop his ability to turn off these feelings.

B. Physics Content: The physics content in this course is designed to emphasize the processes of physics. The students are led to develop their ability to ask questions of nature, to obtain *quantitative* data relating to those questions, and to formulate appropriate hypotheses to answer those questions.

The students in this course learn physics content by direct experimental work and personal interaction rather than through lectures or reading textbooks. No textbook is provided. A sufficient amount of factual material is presented to the student on a handout with each experiment.

The primary role of the physics instructor in this course is to devise simple subsets of nature for the students to examine. The students must develop their quantitative skills of measurement and computation to obtain some experimental data. They must develop some basic analytical skills to formulate hypotheses. They learn about the variables of their experimental systems, which variables they can manipulate and which variables respond to the manipulation of other variables. After they have collected their data, they formulate an hypothesis about their subset of nature. Then they ask the instructor for an unknown for them to use to test their hypothesis. If they can substantiate their hypothesis they are graded competent over that material and proceed to another system. Perhaps a few examples will more clearly explain this procedure.

One of the mechanics experiments is for the students to examine the properties of bouncing balls.[9] The students are supplied with a variety of balls and measuring instruments. They are asked to list the variables of a bouncing ball that they can manipulate and what variables respond to these manipulations. They quantitatively change a variable and measure the change in the responding variable. Then they formulate a quantitative hypothesis that can be tested with an unknown ball received from the instructor. One pair of students had accumulated data using a ping pong ball, a tennis ball, and a golf ball. They hypothesized that the height of the first bounce of a ball is proportional to its weight, assuming all balls are dropped from the same height. The students were given a small steel ball to use to test their hypothesis.

After a preliminary investigation of temperature and heat the students are given an experiment to formulate a hypothesis to predict the final temperature of a mixture of hot and cold water.[10] They are given a variety of containers, a thermometer, and supplies of hot and cold water. After measuring the original temperatures and volumes of various water samples they mix them together and measure the final temperatures. From these data they develop their final temperature hypothesis. Two students formulated a zeroth-order algebraic equation which was composed mostly of numbers but did include two symbols.

It is not possible for us to express their astonishment (and ecstasy) at being able to use their equation to predict and then verify the final temperature of the mixture of the cold and hot water samples furnished to them by the instructor!

In optics the students investigate quantitatively the image forming properties of a simple lens. The students read the operational definitions of focal length, object distance, image distance, and magnification. They are given an optical bench, a lamp for an object, a convex lens, and a paper screen for the image. They are asked to measure the focal length of their lens and to investigate its properties by examining the images that the lens will form for various object and image distances. They record the object distance, image distance, image size, image orientation, the sum of the object distance plus the image distance, and the product of the object distance and the image distance. After collecting considerable data and not seeing any obvious relationships, the students discuss various alternatives with the instructor. Several graphs are suggested among which is a graph of the object-image distances product versus the object-image distances sum. The students are then to formulate a quantitative hypothesis that relates object and image distances. After formulating a quantitative hypothesis for their lens they are given another lens of different focal length and asked to predict the location of the image of a light bulb placed 100 cm in front of the lens. Their prediction is then tested experimentally. Would you believe that they are surprised to find the image where they predicted it to be?

The materials used in the course are as simple as possible. Most of the apparatus is the same as is available and used in elementary schools. Some of the activities in the course could be done by fifth and sixth grade children. The use of these simple materials in elementary activities makes clear the challenge to obtain information by inquiry methods.[11] Occasionally more sophisticated equipment is used by the students, such as a laser, an oscilloscope, or electronic calculators. (An oscilloscope is complicated enough to drive these students to distraction, a good time to hold a short class discussion about the TA techniques that can be used to "stay in the Adult.")

C. Science Teaching Methods: During this part of our course the students are introduced to the processes of learning as identified by *Science — A Process Approach* materials.[12] The Piagetian model of intellectual development and the PAC model from transactional analysis are used in classroom observations and with teaching materials.[13] A more complete discussion of this part of our course is published elsewhere.[14]

Summary

The combination of inquiry learning and transactional analysis offers numerous opportunities for students to have OK experiences in physics. In fact, we believe this combination is not limited to the physics-science teaching methods combination of our course. The inclusion of transactional analysis in courses where social interaction is important seems desirable for all students.

The tools of transactional analysis support the positive reinforcement (positive strokes) aspects of performance learning. A student can use the PAC model of TA to improve his social interactions in the laboratory of an inquiry oriented, performance based course. Thus equipped the student is in a better position to reinforce a positive self-image of himself and develop his potential for winning in life through successful experiences. He is free to decide that he is OK and so is physics.

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