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A NOTEWORTHY PHYSICS PROGRAM: IS INDIVIDUALIZATION THE ANSWER?*

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In The Beginning

My career as a physics teacher began in 1938. This was the year that I was assigned to teach my first physics class. My undergraduate field was biology. I needed something to compensate for my very inadequate background in physics.

The Bible

The school had adopted one of the prominent physics texts of the day. I ordered the laboratory manual that was designed to accompany the text. To see a copy of this text is always a nostalgic experience for me, because this text was my salvation. With this textbook in hand, I didn't need to know much about physics to *teach* physics. I could learn all that I needed to know by reading the text ahead of the students.

The textbook established my physics curriculum. The *Table of Contents* was my course outline. The textbook served as my security blanket. I could predict with reasonable accuracy what was going to happen in class each day. Planning for each day's work was simple and definite. I read a chapter of the text and then assigned these same pages with the hope that the students would also read these pages. In order to increase the probability that the students would read the assignment, I assigned some selected problems at the end of the chapter. These assigned problems also provided something to do during the class period. Much of the class period could be spent by having students at the chalkboard demonstrating how they worked the problems. The anticipation of embarrassment at not being able to work an assigned problem served as a motivation to do the assignment.

While the problems were being worked at the board, the students could correct their papers. This spared me the time consuming chores of correcting papers. Since I had the option of selecting the problems to be assigned, I could select only those problems that I could work. At the most, the students would only bother with assigned problems. This was some extra built in protection for the teacher.

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Part of the class period could be consumed in "*supervised study*" which involved using class time for the students to work assigned problems. This helped to assure that the students would do their assignment and this also insured against those awkward parts of the class period during which the teacher has run out of something to do.

This textbook method was well structured. Class sessions were held on Tuesday, Thursday, and Friday. On Monday and Wednesday a two hour block of time was provided for physics laboratory. The laboratory manual was very specific regarding the apparatus, the measurements that needed to be made, the blank spaces in which these measurements were to be recorded and the specific calculations that needed to be made. The laboratory activities were seldom synchronized with the classroom activities, but this didn't seem to bother anyone. Fortunately, this laboratory manual had enough standard experiments to take up one year's laboratory time.

This textbook course also had a number of other advantages worthy of note. It waas possible to pace the physics course to cover the text in one year. I divided the number of pages in the text by the number of anticipated school days to get a figure concerning the number of pages per day. This figure served well as a base or guide to be used in making assignments.

The school administration was aware of what I was teaching in physics if I covered the text. This textbook was in such extensive use nationally that it established the accepted physics curriculum.

Grading was an exact science with this textbook approach. There could be little quibbling about any grade that I gave. The students and parents knew how to interpret the grade, or at least how the grade was determined. I gave arbitrary points on the laboratory exercises, daily work (doing problems) and tests. I just distributed the sum of the points for each individual on a normal curve and then would let the consequences fall where they may.

Accountability through some form of assessment was more prominent than it is now. The chief instrument of assessment was the State Board Examinations which were prepared by the State Department of Education. It was most profitable for a teacher if his students did well on these State Boards, and conversely, it could be disastrous if the median score of a school was too far below the state norms.

A good textbook adequately taught would almost insure acceptable test scores on the assessment tests. These tests were based upon the most acceptable physics texts and these texts were uniform in the topics covered in physics.

To further insure a good showing on the State Boards, it was possible to obtain special workbooks that contained test questions (with acceptable answers) from previous State Boards. The teachers found the State Boards threatening, but this was more than compensated for by the fact that the students also found these same State Boards threatening. This eliminated the end of the year doldrums that concern so many teachers today. The problem is based upon the idea that the teacher's function is to teach and the student's function is to learn. As the school year drew to a close, the students finished before the teacher. When the State Boards were administered, the students needed to strive up to the last moment of class to pass the tests. Taking the tests was always the last class activity. This served as a very effective climax for the year.

I hope that I have now convinced you that the textbook-lab manual method is the way to go. After one comfortable year with the textbook as my guide, I abandoned this approach to teaching physics. Let me explain why I left the security of the textbook.

Then There Was Life

I was also teaching biology. The biology course was centered around small group and individual projects. For example, we made a detailed study of an aquatic community, a beaver dam, the fish of the region, bird migration, hybrid vigor of corn, plant and animal nutrition. Biology was exciting, it generated some significant student involvement. Students were on field trips whenever they could find the time and opportunity. They were fascinated by their discoveries. Anticipation and meaningful involvement kept the interest high.

By comparison, physics was drab and just another course to occupy the time of the students and the teacher. At the students' suggestion and urging, I adopted the project method in an attempt to make physics more meaningful and vital. I recall that several boys investigated the applications of physics on the farm. Several girls investigated the physics of the home. One boy that planned to become an engineer worked his way through a college physics text. Several boys made a special study of electronics. Physics came to life. At least it took on some significance.

The project method fell victim to a number of influences. With the advent of Sputnik and the intellectual development push in education, it was deemed that the project method did not produce a broad enough base in education; that the seco dary level was not the time for specialization. Also, the projects dealt with applications of science or technology. The field of science was arbitrarily divided into pure science and technology. Science educators ruled that it was the mission of the science teachers to teach science and to avoid technology as much as possible.

Heaven

Under the influence of the times, I formulated a rather lofty philosophy and proceeded to develop an individualized physics course that I was convinced would implement this philosophy. The course was designed to enable each individual for formulate or "*fabricate*" physics related ideas that are relevant to any situations or set of circumstances.

I set out to use two compatible approaches to intellectual development. The process approach was to involve students with the processes of science as formulated in much of the literature related to science teaching. The structural approach proposed to achieve knowledgeability in the vast domain of science by developing a structural framework of scientific principles that were to be learned in a sequential pattern. This conceptual frame of reference was to be structured and presented so that each individual could fit new experiences into the emerging conceptual schemes and thus perpetuate his learning.

The skill required to fit knowledge effectively into the structure and to give perspective to the understandings was to be developed through actual experiences with the processes of inference, prediction, measurement, classification, formulating hypothesis, interpreting data, communication, model building and mathematical operations. These skills were to be combined with experiences in the modes of reasoning (*i.e.*, inductive and deductive reasoning) reasoning by analogy and the use of intuitive reasoning. I attempted to organize the course around evolving conceptual schemes and unifying themes.

What I was attempting to do was the educationally "in thing" for this era. Educators had visions of producing highly intellectual individuals who would be able to cope with an advanced technical society and advance the technology to make us a secure nation in which scientific discoveries would enhance our way of life.

It seemed that this philosophy could be implemented most effectively by using a system of individual pacing. This required the series of sequential packets which would serve to guide individuals or small groups (teams) as they worked at their own rate. It was necessary to develop a system of feedback evaluation so that all involved would be aware of the progress being made.

Two factors contributed to the initial success of this physics program as it was being developed. The course was oriented toward intellectual development. Intellectual achievement carried a high level of prestige at this time. Also, I enlisted the help of the physics students in developing the materials. This provided the element of meaningful and purposeful student involvement that is essential in maintaining a high level of interest and performance on the part of students.

Revelations

Since the course was developed, the glorious image of intellectual achievement and its contributions to technology have become somewhat tarnished. The demand for great scientific minds has diminished as reflected by the employment picture. Technological advances have been cited as contributing to some of our major problems. Technology has been blamed for pollution, food additives and drugs that affect our health adversely, insecticides, fungicides and herbicides that have an unknown effect on our environment, radiation dangers and the diminishing of the ozone layer.

In the minds of many, these adverse effects overshadow the contributions of technology to our welfare. Since technology got us into these dilemmas, it seems logical to assume that technology should be able to get us out. There should be a new surge of emphasis on technology as we search for new sources of energy, try to clean up our atmosphere and water, and search for cures for some of the unconquered diseases such as cancer. This emphasis on technology should now become the recognized direction that physics teaching will take. I predict a renewed emphasis on these current topics.

Judgment Day

Appraisal of physics courses seems to be based upon the educational concern at the time that the appraisal is made. We are especially concerned about the decreasing enrollment in physics courses. The number of students enrolled is often used as an important indicator of the success of a physics program.

The merit of physics programs is judged on the basis of how well the outcomes fit our concept of what physics teaching is all about. In the pre-depression era, physics courses were judged on the basis of the level of performance on textbook materials as incidated by the scores on standardized tests. During the depression, the contributions of physics to consumer science seemed to be the most important factor. During the Sputnik era intellectual development was the big thing, and at the present time we are tending toward what physics-related technology can contribute to restoring or preserving our environment and our way of life.

Before wise decisions can be made on individualization and what form it should take, one needs to consider what one hopes to achieve with a physics course. Teaching methods are then selected that will most effectively implement the goals which one has set. One should not get on a band wagon just because it happens to be going by. Teachers need to determine that the band wagon is going where they planned to go.

Salvation?

In 1975 I received the Outstanding High School Physics Teacher Award. I deemed this a great honor. The physics program that was appraised relative to this award evolved over a period of almost forty years. It might seem that if I really worked at improving the physics offering for this period of time, I should have a physics program that could be classified as the most outstanding program or the ultimate in physics teaching. Unfortunately, I don't claim this outcome of all of my efforts. I made changes because of a sense of dissatisfaction with what I was doing. I still have that sense of dissatisfaction.