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ABSTRACT

The instructional program for first year college chemistry was altered to provide self-paced, individualized instruction using multimedia modules. Each unit must be passed before the student can proceed and thus all students who complete the program can be assured of a passing grade. The entire course is on 42 half-hour audio tapes; students use these, the textbook, and other students for help in learning the material. In addition, the laboratory section is individualized so that all units are always available, and some demonstrations have been video taped. The course has been evaluated by student questionnaires during the three years it has been in operation. (WH)

INDIVIDUALIZED HIGH SCHOOL CHEMISTRY

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I wonder how many of us would want to live in a house which is built on a foundation of cement which was not allowed to harden, or which because of lack of time had only a minimum of support beams put into place before the rest of the house was built on them? And yet, that is exactly what we ask of our students taking sequentially oriented courses if we don't give them time enough to digest and understand some material before moving on to other ideas which presuppose a working knowledge of that base. I would bet that most of you share with me the frustrating experience of just getting to a point in some area where we are just beginning to understand it and we are told that"it is time to move on". Out of self defence we are forced to "skim the top" and learn just enough facts and procedures to be able to regurgitate them on a test in order to pass; but a few days later we have very little understanding of what we did, or why. This is precisely what I have seen happen to many of my students in chemistry classes which are sequentially arranged.

I find this rather unsound educationally, on several counts:
First, I don't believe the basis of education should be on rote memory. Certainly memorization has its place, but I feel we should aim for understanding of concepts and the interrelationship of these concepts.
Second, we distort the idea of what constitutes learning in the student's mind.
Third, students generally will not be satisfied with their performance even if they pass the tests because there is so much which is not understood, and this tends to lower their self image as a student.

Something which bothers me greatly, and is perhaps the greatest injustice which the public school systems perpetrates on its young people is the fact that we as educators are so preoccupied with cramming information down their throats, that we don't give them a chance to structure their learning. We tell them what pages to read, what questions to answer and when to have this done. They are not allowed the opportunity to fail and then pick up the pieces and try again; and by this action we are not properly preparing them for the future. When they leave high school, the world of work or college will in effect say to them "here it is, if you want it you will have to work for it, and if you're not willing to do the work, someone else will". Half of my freshman class in college dropped out by the beginning of the sophomore year, not because they were unable to handle the school work, but because they were unable to handle the freedom they were experiencing for the first time.

I feel it is time to reevaluate priorities!

Public education has the following responsibilities:(basically to prepare the graduate for what will follow). I used to feel that preparation in subject matter was of prime importance, but now I feel that there are greater values such as:

1) to give each student every possible opportunity to find success, and to build a positive self image. Many students shy away from courses which have reputations as being "hard" for fear of destroying their self image.
2) The vast majority of the student's life lies ahead of him. Public education should help to instill the love of learning so that he will continue to want to learn for the rest of his life.
3) Create a positive attitude toward subject area. Particularly in my area, we must build a scientifically literate and sympathetic citizenry if we are to overcome the major problems which face our society today. Don't

make the subject so unpleasant that the student wants nothing to do with it after high school.

With these considerations in mind, and with the full cooperation and blessing of the school district, I started developing the framework within which the student could:

1) proceed at his own pace so as to have sufficient time to digest the material
2) develop the self discipline and study habits to be able to complete the course without the imposition of firm deadlines
3) to give credit for what was done rather than to penalize for what was not.

In order to accomplish these goals we:

1) Removed the time limit from the class, allowing the student as much time as necessary to complete the curriculum (which was basically the same as had been previously covered in a one year period).
2) Set up a grading system under which it is impossible to fail the class. Each student has to test out at the end of each unit to both his satisfaction and to mine. I had to feel confident that his background is strong enough to build on, and the student has to be happy with the grade. All grades are based on points earned out of possible points on the test, lab report, etc, and at the end of the semester points are averaged and letter grades assigned (A,B,C none lower). A student may take as many tests (written and/or oral) as are necessary to reach this point. The test then serves as a learning tool rather than as a weapon.
3) Each student is given a course outline indicating the sequence of work to be covered, the experiments which are to be performed with each section, and a suggested time schedule to be followed if the course is to be completed in a one year time period; a set of behavioral objectives for the course indicating what is expected in each of the units; and a blank schedule. The student is asked to set a target date by which he would like to complete the course. A schedule is then tailor made for each student indicating intermediate target dates by which he should be at various places in order to finish in the desired time. This schedule is reviewed and revised monthly or as necessary.
4) The curriculum is a broad enough one to allow the student to be familiar with all of the concepts covered in the ACS-NSTA first year chemistry exam. I have not yet come to the point of believing that students at this level have sufficient background to make a reasonable value judgement as to which parts of the course they need to study, and which they can omit, so the course of study is the same for all students.

It became obvious that to do this the class could not be called together for traditional lectures, so video tape equipment was purchased and the lecture material was put on tape. The entire course is on 42 half hour tapes, and is broken into specific lessons called "mini-lessons" dealing with small topics and lasting from 3 to 22 minutes in length. Students are given a list of the mini-lessons, the tapes on which they are found, and a cross reference with the material in the text book.

Students are given the choice whether they wish to use the textbook, the tapes, help from other students, or any combination of these to help them with the material; and are asked to determine for themselves which method of learning works best for them. The tapes allow the material to be rerun as many times as needed and also allow a student to go back and review the material without having the possible embarrassment which might accompany such a question in a traditional classroom.

Multimedia approach to this class includes, in addition to the text and the tapes, additional resource material which includes written answer sets to the questions and problems at the end of each chapter in the text; a lab program which is correlated to the course and which hopefully will tangibility to otherwise abstract concepts; models; and last but I hope not least is teacher availability. I can sit down with

an individual student or group of students (students are encouraged to work in groups) and hopefully help them over rough spots taking 10 or 15 minutes (or longer in some instances) if necessary, even with a single student. With four video monitors in the room, I can be in 5 places at once, and my role can be one of a "trouble-shooter" going where the difficulty is and passing by those students who are doing fine. The system seems to work reasonably well with class sizes of less than 20, although the time gets a little short when the class size gets over 15.

The individualization of pace brought with it some logistical problems regarding the lab program, and it was necessary to put together trays for each experiment with the equipment and reagents not found in the usual student equipment trays or reagent trays, in order that each of the various experiments would be ready at all times. Also there are some of the experiments which have demonstration portions, and these demonstrations have been put on video tape.

Evaluation of each student's work is an ongoing process measured partly by test scores and partly by the periodic reassesments of schedules. The ACS-NSTA exam is used as a final exam to give both the student and me an idea of their preparedness so far as subject matter is concerned.

The program has been in existence for three years now and I have tried to evaluate its impact in a number of ways. Student questionaires have shown that students are in favor of this method of instruction (as compared to the traditional approach) by about 4 to 1. I have a long list of student comments, but thought that the following sample quotes might prove interesting indication student feelings:

1) I feel it is much better to work at one's own speed and understand it, than to race along from chapter to chapter.
2) I think that sometimes I get lazy and don't push myself enough; but think I'm getting better at it and I will start keeping on schedule. I think the "no time limit" approach is the best way to run a chemistry class.
3) I find it satisfactory because each student must realize that his success or failure in the class is entirely up to him.
4) It's kind of an equal opportunity class where anybody can take chemistry, where before probably many turned away for fear of falling behind.
5) I think it is really good in that I seriously doubt if I could even pass if we had to cover the material as a class. It also teaches responsibility.
6) I think the no time limit is very good because we can set up our own time limit and we aren't held back by others, or expected to live up to someone else's expectations.
7) I don't feel I would be passing this course on a time limited approach.
8) It gives me the total responsibility of my work and helps me to learn self discipline.
9) The class is harder than I thought it would be, and the no time limit gives more time to let the material sink in.
10) I really think that it's important to have individualized instruction or "move at your own pace" classes in high school, because at least from what I've heard, college is almost all that type of class.
11) I believe that I have learned more than I would have if this had been a traditional method.
12) If I were taking this class in the traditional approach, my grades and level of understanding the material would be considerably lower.
13) The pressure on accomplishing certain goals at a certain time is eliminated. It teaches you to propel yourself through this work; it teaches determination and independence.

In general, those favoring this method did so because they found that they could understand the material better; and those who opposed it did so because they felt the need for structure, and were unable to cope with the freedom allowed.

My assessment of the strong points and drawbacks of this approach can be summarized in a comparison of the disadvantages and advantages. In many instances they can be shown as a conjugate pair.

Disadvantages	Advantages
Not all students work well "on their own".	This system allows time to get a better understanding. On the ACS-NSTA exam prior to and including 1971 the average percentile ranking of my students was 51.4.
	Since 1971 — %ile ranking — % increase those completing the course — 67.7 — 31.7 all (corrected for amt of course completed) — 62.2 — 21.0 all (uncorrected) — 57.2 — 11.3
	(even students w/1 semester do well in college)
The average student takes more than 1 year to complete the course.	As indicated before, most students like the approach. The slowness may be due to one or more of the following reasons: 1) The material is covered more completely than previously 2) Because there is no time limit, I have to compete with other subject areas, or classes which do have deadlines. 3) The freedom does allow students with a tendency to be lazy to "goof-off". 4) It takes students a while to get used to this approach and the idea that they should do work out of class even if it isn't specifically assigned.
It is difficult to create internal motivation.	Particularly among those students who must return for a second year, there have been dramatic changes in attitude and performance which would not have come about had they not had to face the concept that finishing was up to them.
Chemistry takes a low priority and there is a lack of outside work.	When pressure is removed students can relax and enjoy the course more.
Requires preparation in all parts of the course at all times. This would not work well with many excellent teachers.	I find this approach more stimulating and find that I have a better overall view of the course and the interrelationships of ideas by this method.

Additional advantages and disadvantages not necessarily paired

Some students don't seem to be able to "warm-up" to a T.V. and they find it very impersonal.	Students can start at any time of the year, and can interrupt their studies. We have biology students who are able to finish in March or April and can start in chemistry.
	There is a great economy in lab equipment necessary when complete class sets are not required.
	Since the pressure on grades is removed, the need to cheat is reduced or removed.

In all probability the course will be offered in both this mode and the traditional mode to truly individualize the course for as has been indicated there are those students for whom the "individualized" approach is not suited and who need more structure. Also, work needs to be done on a method to stimulate students to work faster. But, even with all of its shortcomings it seems to show great improvement over the traditional method which I had used before.