Toward an Open Curriculum: the 333-Question Course

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In all the mathematics and science courses that ever took in high school, or as an undergraduate at the University of Toronto, or as a graduate student at Stanford, I usually had no idea of what the teacher or professor was talking about.

At the time, I did not blame my lack of comprehension on the educational system - I blamed it on my own lack of preparation. But recently I have been re-exposed to mathematics and science courses at the University of British Columbia (UBC) under different circumstances and with a different attitude. Now I was mature, disciplined, and motivated. Now I not only did my homework, but I did it several times, and did more than was assigned. Now I read ahead and often knew the material well enough that I could have delivered the day's lecture myself. Now I was getting high marks. And so now what did I find? Several things?

In the first place, when I had learned a topic beforehand, then yes, I could follow the lecture - usually. Also, now that I was reading ahead, I could see how often the material must be incomprehensible to anyone who was hearing it for the first time - the instructor might fail to stress some critical point, or he might word something poorly, or he might be unaware of some simplification that was possible or some mnemonic that made the whole easy to remember.

And I noticed something else: professors made mistakes. Even the most competent ones made one or two per lecture. Mistakes were inevitable because mathematics and science lectures often involved the continuous writing of proofs or else the solution of complex problems, so that over the course of an hour the lecturer might cover several blackboards with densely-packed symbols over and over again. What often happened was that I would pause and look around, and see all the other students contentedly continuing to copy from the blackboard, mistake and all. And often, the mistake was far from trivial - rather, it was so gross that anyone who was following the lecture must have immediately been struck by it. Seeing that nobody else was going to say anything, I would then point out the error.

THE ZOMBIE HYPOTHESIS

As this failure of students to catch errors repeated itself, I began at first to entertain, and later to be entirely convinced of the truth of, the zombie hypothesis - that in a typical mathematics or science lecture, from zero to five percent of the students are following what is being said. These are the non-zombies. You can guess the rest.

There is something else that happened that has a bearing on the zombie hypothesis - and that is that sometimes I would not have read ahead and mastered the upcoming material. Perhaps I had not had time, perhaps the professor was not following any predictable path through the textbook, perhaps it was a lecture course and there was no textbook. In all such cases, I usually had no idea of what the professor was talking about. I had rejoined the ranks of the zombies, for a zombie is what I had been throughout my youth. And so now I was catching no errors, and when some non-zombie did catch an error, it seemed like a miracle to me that he was able to do it, and my having copied down an error without objection stood as a just accusation of my total lack of comprehension.

Are course instructors aware that almost nobody - and sometimes absolutely nobody - is following them? Well, their behavior suggests that they are aware, for they studiously avoid any action which might provoke a confirmation of the zombie hypothesis. For example, I never saw a UBC instructor in mathematics or science address a question to a random student. An instructor might ask a rhetorical question. More rarely, he would put a question to the entire class, and here he might be saved by one of the few non-zombies providing an answer; or if no answer was forthcoming, the instructor would provide it himself, an outcome which was nondiagnostic in that it was possible to ascribe the students' silence not to universal catatonia, but rather to a shyness. More rarely still, the instructor might put a question to some obvious, card-carrying non-zombie. In one three-month half-course that I took, for example, the instructor asked exactly one question, and this he addressed to me. But what no instructor ever did was address a question to a random student - and the reason was that he knew that most of the time he would get no answer and the zombie hypothesis would be confirmed. Let sleeping zombies lie is a rule that avoids much unpleasantness.

But the zombie hypothesis is not something any lecturer should believe on the basis of someone else's observations - he has it within his power to put it to an empirical test at his very next lecture. All he needs to do is to ask every once in a while, "Would all the people who understand everything I have said so far please raise their hands?" Better than that, he can intentionally introduce several subtle and yet fatal errors into every lecture, and a line or two later, pick the name of a student out of a hat and ask him whether he sees anything wrong. Or the instructor can erase the last few lines of a solution or proof, and ask a random student to come up to the board and reconstruct what has been erased. The best thing that he can do is to deliver a lecture on an unannounced topic and then give an unannounced quiz on the material covered in that lecture - there is no surer way to elicit mass failure and howls of protest. Even an announced quiz at the end of a lecture covering that day's material is not to be thought of. Such things are never done and for good reason - the lecture hall is not where learning takes place.

"ANY QUESTIONS SO FAR?"

Although genuine verifications of student comprehension are available but unused, bogus checks are commen a lecturer mightsay something like, "Any questions so far?" and take the ensuing silence as indicativeof perfect understanding, not troubling himself with the possibility that it may also be indicative of a perfect lack of understanding. I recollect a case in which an instructor invited anyone in the class to request from him a repetition of the last portion of the lecture, saying "If even one students says he didn't understand and wants to hear it again, I will repeat it." Nobody raised his hand. I hadn't understood him and didn't raise my hand. I didn't want him to repeat anything. He had been incomprehensible when he had presented the material the first time, and he would have been just as incomprehensible the second time. The material was too complex to be grasped by means of passive viewing - I needed to work through it by myself. If this instructor had not been shamming, he could have begun to get a rough idea of the level of student comprehension by employing any of the checks outlined above, but as this might have proved embarrassing, he preferred his bogus check which gave such complimentary results.

But if the zombie hypothesis is true, then what are all those students doing there? Well, in the first place, they are not all there. Full attendance is not the rule, it is the exception. Full attendance usually means one of four things: a test is being given; it's a lecture course without a textbook; or it's a small class and attendance contributes towards final grades. Then on top of that, of the students who are in attendance, large numbers of them are not paying attention: some chat with their neighbors throughout the entire lecture, some read newspapers or work on unrelated material, some come for a few minutes and then walk out, some doodle and gaze around without taking notes, some sleep.

So then what is going on? If the amount of learning that takes place in a lecture is really close to zero, then why are any students coming at all, and why do others come and then behave so inappropriately?

From the point of view of the student, the chief role of the lecture is to provide curriculum definition. That is, when the course begins, the students does not know what is examinable. She usually has a textbook, but it may be some 800 to 1,200 pages long and may contain anywhere from 2,000 to 10,000 problems. And yet in a typical half course, she might only have to read a quarter that number of pages and might only have to solve one-twentieth that number of problems, and she has to come to class to find out which pages and which problems these are. She also comes to class to learn the dates of the tests and what these test will cover to get homework assignments, and to obtain other procedural information - all of which I include under the heading of curriculum definition.

Obviously this curriculum definition information could all be made available on the first day of class, but it is not - it is released in dribbles over the duration of the course. Oh yes, there is sometimes a course outline indicating what pages are to be read, but this outline is skimpy and unreliable. It is skimpy chiefly in that while it may indicate what pages should be read, it will not indicate what problems are to be solved. And it is unreliable - for example, in physics, I learned the Wheatstone Bridge, Young's modulus, shearing and compression, and Hall's method of distinguishing p-type from n-type semiconductors because these topics were on pages assigned in the course outlines. None of these topics however, turned out to be on the course. So, if the student wants to avoid doing unnecessary work, the advisable thing to do is to come to class and listen for curriculum definition information - the inadvisable thing to do is to follow the course outline.

And students have to stay on their toes at all times, because the curriculum is constantly being shifted on them. For example, the students are given a handout, it is discussed, they invest time learning it - but then later they are told that they don't have to know it. They are given problems for homework, they complete them and hand them in - and they are then informed that two of the problems won't be graded because they involve concepts that are not required for the course. They copy down proofs of theorems in class, later find out that they needn't have bothered because these proofs are in the book - and as test after test fails to ask for any proof, they eventually glean that proofs are not examinable.

Here is a representative experience. In a computer science course, supplementary texts were recommended and stocked at the bookstore, in which I found on page 16 of one text, page 17 of another, and page 35 of a third, a description of the so_id expression. The latter text described cond as "Scheme's most general and powerful tool for making choices. In fact, once you have read this section, you don't ever have to use if again, since any if expression can easily be rewritten in cond form." (Eisenberg & Abelson, Programming in Scheme, 1988, p.35). And so on one of my lab assignments, I did use this general and powerful cond instead of the more awkward if. But the instructor had not lectured on cond, and the marking key that he had provided the teaching assistant who was grading the labs used the more elementary and more awkward if. This teaching assistant had had no previous exposure to the Scheme language, and so he did not recognize the cond in my lab report, and the teaching assistant complained. As a result, the course instructor announced to the class that the use of any expressions not covered in lectures would be penalized.

In other words, course instructors are in a continuous process of defining and redefining the curriculum as they go, of recommending material that they will penalize the student for using, of presenting material that they have no intention of ever testing, and of skimming cursorily over material that they intend to test in depth. The student is obligated to keep a vigilant eye on the instructors as they struggle to make up their minds, and as they release hints and clues and revisions and even conscious disinformation. One of the hardest tasks put before the student is to construct a picture of the examinable curriculum - somewhat like an archeologist trying to piece together a vase from the shards brought to her one or two every other day, and where some shards will never be found, and where some that are brought to her will not be from her vase. Students who acquire skills in curriculum inference will find that such skills help them as much as hard work in their struggle to earn a degree.

...ACCOMPLISH MOST OF THEIR LEARNING IN A SMALL NUMBER OF CRAMMING SESSIONS

Now let's get back to the students in a typical mathematics or science lecture hall - why do they act the way they do? Here is my guess. As curriculum-definition announcements tend to be made at the beginning of class, that is why some of them come for the first few minutes and then leave. This was most evident in a case that was described to me in which an instructor started each class by projecting on a screen a summary of the last day's lecture, and where students would be seen copying down the summary and then leaving before the current day's lecture began. When homework is due, students who have not done it come to class to copy it from someone else. As for the students who don't come at all - they have trusty friends from whom they can get the curriculum information. The somnambulists sleep during the portion of the lecture that is incomprehensible anyway, but were awake during the critical first few minutes, and at the end of the lecture they will be in a position to have some fellow-student inform them of any curriculum-relevant announcements they may have missed while asleep. The chatters, the newspaper readers, the doodlers, and the crossword-puzzle solvers have given up trying to follow the lecture, and find that even while chatting or whatever, they can still pay enough attention to catch any curriculum definition information that may be tossed their way. In a no-textbook lecture course where students are forced to take notes, they find that conversation does not interfere appreciably with the mindless transcription of meaningless symbols, and so they enliven their copying with chatting. And so maybe that's why the zombies are and that's why they're all busily scribbling away.

Now I don't mean the word "zombie" derogatorily. Fundamentally, there is nothing wrong with these students. Outside the lecture hall they are overall a decent, considerate, attentive, and responsible lot. But in the lecture hall, they sense the game in which they are being forced to play the pawns, and they participate on their own terms - grudgingly. But their negligence and irresponsibility are superficial and situation specific - if one looks not at their classroom behavior but at their accomplishments then one gets a very different impression, for where society credits them with mastering a year's work in a year's time and only with the help of their teachers they in fact accomplish most of their learning in a small number of cramming sessions and largely on their own. Under more optimal learning conditions, students with such demonstrable powers could accomplish miracles. I started out calling them "zombies" because they had no idea what the lecture was about - but this it turns out is no sin, for it is almost impossible for anyone to know what the lecture is about. If students are guilty of any sin for which they deserve the label "zombie" in a derogatory sense, it is the sin of failing to grasp that they are being victimized.

Now on the one hand, the confirmation of the zombie hypothesis is very bad news - it tells us that mathematics and science students have the bulk of their lecture time wasted. But on the other hand, it is very good news because the situation is easily remedied by adopting an open curriculum, and the remedy brings with it several astonishing benefits. The remedy, furthermore, is not totally unprecedented - it is merely an extension of something that is being done in the occasional course with great success.

Imagine, now that for a calculus half-course lasting three months, the student purchases at the book store a booklet containing 333 core problems, and is told that being able to solve these 333 problems constitutes the course. (The number 33) for a half-course is arbitrary and the optimal number will vary - for some courses, a much smaller number will be appropriate. On any examination, the student will be asked to solve some sample of these 333 core problems, and of course the problem on that examination will be altered by changing the coefficients and the variable names. Such changes will make it unprofitable to simply memorize the correct answers to the 333 core problems.

Now it is important that every problem also come accompanied by a complete and optimal solution, or with several alternative solutions where more than one is possible. Without complete solutions, the student will often get stuck and find herself unable to continue - and in such a case, what is she to do? Why she is to wait until the professor's office hours, which may be several days removed, and then she is to stand in line cooling her heels, and eventually she is to scribble down something that the professor says and take it away with her to her own desk where she can begin to think about it - that's what she is to do. Mind you, she might have a hundred more such problems waiting to be done after the one that stumped her, and so this getting into line to obtain each piece of information may strike her as cumbersome and inconsiderate of her time - but that's what her instructor deems best for her, and that's what she's stuck with. And that's not even the worst case. A worse case is an instructor who refuses to announce his office hours and who does not answer his door when a student knocks, pretending he's not in, holding his breath, playing Run Silent, Run Deep as the depth charges of those repeated knocks probe for his presence, and surfacing only when a graduate student knocks and whispers at the door, "Vance! It's me!" That is worse, and that does happen at UBC. But surely any of this sort of inconvenience and delay in obtaining information is insufferable. Surely students must be given complete solutions so that when they get stuck they can unstick themselves without delay.

STUDENTS MUST BE GIVEN LECTURE NOTES

And there is a third thing that the students must be given - lecture notes. Not just any lecture notes, but a really good set - a superb set. Such lecture notes would differ from a textbook in that they would be both necessary and sufficient, which a textbook is not. Copying these lecture notes off a blackboard day by day is not an acceptable alternative to being handed the whole batch of them at the beginning of the course. There can be no justification for making students come to class to copy things that they aren't going to understand at the time of copying, and when the resulting notes are sure to be defective - defective because as the lecturer is writing on the board, he is bound to make a mistake or two (which may or may not be caught by someone); and then as the student is copying off the board, she is bound to make a mistake or two more; or defective because the student may happen to have terrible handwriting; or may be sitting at the back and mistake some small or faint writing on the board; or may have her view obstructed by a projector or the body of the lecturer; or may be unable to hear clearly what the instructor is saying because of the babbub in the room; or may be late coming to class or may have to miss a class; and so on, and so on. A case came to my attention in which the instructor was at the leftmost of three boards, and a student sitting toward the right in the front row couldn't see what the instructor was writing, and so was forced to copy from the notes of the student to his left.

So we start with a student who has been given her 333 questions, complete solutions, and superb lecture notes, and this is what I mean by "open curriculum" and already it is a vast improvement which by itself will guarantee that such a course will be popular and that the students in such a course will turn out sterling performance. But that is not all - here is the really good part. Imagine that these 333 questions are put on computer, and then a program is written which selects questions for a final examination - a program that picks one question from the first section, two questions from the second section, and so on. Imagine, furthermore, that the computer introduces random changes both in the coefficients within each problem and into the variable names, as discussed above, and so is able to print out sample examinations - as many as the student wants - and also solutions to each sample examination. The real examinations administered by the university, furthermore, are printed out by the same program, so that the students' sample examinations are indistinguishable from the real ones. At the same time, students who are not ready for the final examination but who want to test themselves on what they have learned so far can ask for tests on individual topics. And imagine, finally, that this program is put on diskette and sold in the bookstore for some nominal sum. What would be the result?

UNPRECEDENTED LEVEL OF CURRICULUM

First of all, the students would have an unprecedented level of curriculum definition. They would have the 333 core questions, and they would be told the rules by which the computer selected questions for a final examination, and the rules by which the computer altered the questions, and they would have access to an unlimited supply of sample examinations.

Now this resembles what already happens. Today, it is commonplace for students to purchase past years' examinations with solutions. But doing it on computer as part of an open curriculum would be better for two reasons. One reason is that as things are now, the curriculum shifts from year to year, so that previous examinations cover different material. The second reason is that the solutions presently being provided tend to be prepared by students and are error-ridden. The computer generated sample examinations, in contrast, would remove this shortcoming - every sample examination would be highly similar to the upcoming examination, and the accompanying solutions would be error free.

And as a result, forever abolished from the face of the earth would be examination by ambush - the examination to which the student goes not knowing what to expect, or the examination to which the student goes with reasonable expectations but which asks such bizarre questions that it seems to be from some other course. A computer-based open curriculum would also prevent the frequent miscalculation on the part of the test-setters of the difficulty of an examination, and so would prevent the ludicrous outcome of seventy percent of a class being failed, which reflects not at all on the students, but only on the immaturity and inexperience of their teachers. Indeed, under a computerized open curriculum system, failure might become a rare phenomenon, as students would now be able to pre-evaluate themselves as often as they wished and according to the same criterion that the university would be using to evaluate them, and so if their own pre-evaluations told them they were going to fail, then they might be convinced that they needed to do more work before examination day.

A computer based open curriculum brings other unlooked-for benefits. Today, cheating is a serious problem. On term tests in particular, in a large crowded classroom, the students sit elbow to elbow, with their neighbors' examinations almost as easy to scan as their own. But with computer generated examinations, cheating can be prevented by having the computer generate a different examination, or a different variation of the same examination, for each student. Having many alternative versions of an examination within one classroom would slow grading, but only trivially - each paper would have its own code number, and punching that code number into the computer would produce a printout of that paper's solutions, and that printout could be stapled to the student's answers. The markers would then consult the attached printout when marking, and the student could later use the same attached printout to review their performance.

Still on the topic of cheating - at the University of Western Ontario where I used to teach, my secretary was propositioned by a cleaning lady to steal examination papers for money. My office seemed under constant assault by students trying my door when they thought I wasn't in, usually at night. A student was once left alone in my secretary's office when she stepped out for a moment, and he immediately opened a side door between her office and my own, and stepped into my office, but was unable to account for why he had done so. Thus, a professor's having curriculum definition information that is denied to students makes him the object of theft and corruption. A computer based open curriculum circumvents all such perils by equating teacher and student on their knowledge of any upcoming examination.

...TRANSFORMED FROM AN ANTAGONIST OF THE STUDENT

And there are other things that would be prevented that may not qualify as outright cheating, but that constitute the granting of unfair advantages. As things are done today, one professor may give away more of an upcoming examination to his students than another, or a given professor may happen to drop more hints to a few of his students than he does to others. Teaching assistants may know things about a professor's examination policies and preferences, or they may have seen the final examination, or may have helped in its preparation, and so be in a position to pass along pertinent information to favorite students. Some professors give similar - sometimes identical - examinations from year to year, and students who learn this and discover that these examinations are on file and available for inspection and photocopy can benefit enormously. Some professors attempt to keep all their past examinations from students and refuse to put them on file, but as these examinations have passed through hundreds of hands, a few students are able to obtain copies, and these few benefit greatly. With a secret curriculum, a teacher must hold back and measure how much in clear conscience he can tell any particular student about an upcoming examination. With a computer based open curriculum, he is not only permitted to tell everything he can, but also obligated. He is thus transformed from an antagonist of the student to an ally.

The preparation of a final examination is often more hectic than it should be, so that sometimes a question turns out to be devastatingly hard, or unsolvable, or entirely meaningless. Problems such as these the computerized open curriculum would also sweep away.

The extra labor of devising make-up examinations for students who excusably missed an examination is now replaced by the touch of a button. In fact, there need no longer be any such thing as a missed examination because there would no longer be any reason to herd students into large halls so that they could write their examinations simultaneously. If a particular student felt that she had mastered a three-month course in one month, she could just walk over to a testing center, and if they were booked for the day, she would reserve a time on the next day or the day after, but if there was an empty desk available right then, then the attendants could just punch a few buttons and out would come her examination questions which she could answer on the spot. Graders would be continuously available, and as the optimal solutions could at any time be printed out, the examination could be graded within minutes after being completed. When the student walked out of the examination hall, she could be clutching in her hand, not only her question paper, but also a photocopy of her own answers, a copy of the correct solutions, and her grade. Perhaps this is a little optimistic - perhaps she might typically have to wait a day or two for her grade - but it certainly wouldn't be anything like the unconscionable six weeks that it takes now. And no more wondering if the graders were competent enough to understand an unconventional solution, or whether a certain question really had a correct solution at all, or whether there had been a mistake in adding up her grade - now it would all be open and above board. Now she would be able to review her examination while the course was still fresh in her mind, and while it was still possible for her to understand the reasons for her errors or the nature of the correct solutions. In the present system, in contrast, by the time she gets her marks six weeks later, she has forgotten how to do most of the problems, and so that even if she went to the trouble of petitioning to view her own examination answers, she would only be allowed to view them briefly and what she saw she wouldn't comprehend because it would have been so long since she had studied the material, an she wouldn't be allowed to photocopy her own answers, and wouldn't be given the correct solutions along with the marking scheme, so that she would find it impossible either to understand the course material better from inspecting her paper or to verify whether she had gotten all the marks that she deserved. A computer based open curriculum eliminates all such difficulties and permits a final examination to become not only a means for evaluating the student, but also a learning experience for the student.

And no more examination time-table conflicts where a student has two of her examination scheduled at the same time, or examination pileups where several tough examinations have to be written within a short space of time, or examination spread-outs where some simple examination has to be written weeks after all the others and say, delays her departure for home or for a job in a distant city. And similar things can be said about course scheduling - as things now stand, students must sometimes select only one of two courses that they would like to take because the lectures for these two courses have been scheduled for the same times, or for overlapping times (but this would be less of a problem if an open curriculum released students from attending lectures), and students are often prevented from registering in a course because of limitations on the capacity of the lecture hall in which it is taught (but this ceiling could be lifted if it turned out that few students wanted to come).

The open curriculum would save a vast amount of faculty time. Right now all over North America, thousands of faculty members are all busy trying to figure out which pages to ask the students to read, which problems to assign, what questions to ask on examinations, and so on. And the question must arise as to why these thousands should all be duplicating each other's efforts, when it needs to be done only once on the computer, and from then on it can be improved and refined, but with a far smaller investment of time, and with an increasingly superb product with each revision.

In those lectures whose chief benefit to the student is curriculum definition, an open curriculum will lead to a drop in attendance. If any students should remain who value the lectures either as the primary conduit of course material or as an adjunct to their private study of an open curriculum, then they can continue to attend lectures - but these students will constitute a minority. Such a drop in attendance can be viewed as still another benefit of a computer based open curriculum. It will benefit, among others, students like the 3,300 qualified students who were denied admission to UBC last fall. These students were denied admission because there was no room for them in the lecture halls, but if they could have found seats in these lecture halls, then in many cases they would not have understood what was being said in them anyway. Far better to have admitted them and to have given them adequate curriculum definition material so that they did not need to come to these lecture halls in the first place. And far better to have pocketed their fees too. No news should be met with greater joy by cash-strapped universities than that student morale can be boosted and student learning facilitated while cutting costs at the same time. From a financial point of view, the recipe of the open curriculum is irresistible. Of course some of the savings would have to be passed along to the students.

PROTESTING FEE HIKES

And here is suggested an argument that students currently protesting fee hikes should be using - that most of their tuition goes for things that fail to benefit them - indeed that injure them; specifically, lecture halls in which they do not enjoy being confined and lecturers whom they do not understand. Their time is wasted, their morale sapped, and to defray the expense of this they are handed an ever increasing bill.

To the objection that the open curriculum would teach students how to answer core questions, but that what the university should be teaching them is how to answer new questions, several replies come to mind. First, when one becomes aware of how little the average student actually learns, and that in first-year calculus, something like a quarter to a third of all the students fail, the idea that the secret curriculum system teaches the creative solution of unprecedented problems does not seem credible. Second, whatever questions are asked on an examination must be inevitably drawn from some pool, and so the only issue remaining is whether the student is to be allowed to see this pool or not. If he can see it, he knows what to study; if he can't, he doesn't. Third, the best way to learn how to solve unprecedented problems may be to acquire experience in solving a diverse selection of given problems - and so students coming out of an open curriculum course may be able to outperform students coming out of a secret curriculum course on any examination, whether it contains unprecedented questions or not. Fourth, one wonders whether these are merely variations on problems that have been studied. Fifth, if truly unprecedented questions are being asked, can this be justified? Surely, an examination legitimately tests what a course has taught, and not what some rare genius among the students may be able to answer. Sixth, that rare genius may be merely a student who loves his subject and has had broader exposure to it, so that the problem which for most students seems unprecedented, for him falls within a familiar pool, and so if that question had been included in the core of an open curriculum, prior exposure would have been equalized for all students. And seventh, if difficult and unfamiliar questions are indeed being asked, then one may inquire how many students are answering them correctly. If the purpose of any question is to distinguish the more able students from the less able, then a question that no student answers is a totally wasted question, and a question that almost no students get right is an almost totally wasted question.

For the secret curriculum system that is presently in place, it is difficult to muster any sympathy. It is a system in which the student learns what a course requires of him only by spending many weary hours picking the information out of a stream of unintelligible verbiage. It is a system which pretends that course content is transmitted from teacher to pupil, but where often the pupil understands only the curriculum information that defines for him what he will eventually have to cram on his own. It is a system which places obstacles in the path of learning and then blames the student when he doesn't learn. It is a system by which the faculty establishes a monopoly on curriculum definition information, and dispenses this information to students as a reward for attending lectures and thus for bestowing an air of legitimacy on the lecture method.

Advocating an open curriculum is not at all advocating the abolition of lectures, it is only advocating the removal of one reason for attending lectures - the bad reason of curriculum definition. Upon the removal of this reason, attendance will indeed drop in lectures dealing with topics that because of their complexity are not amenable to being taught by the lecture method, and in some cases that attendance will approach zero. In consequence, the role of the faculty in certain disciplines will change. As things are done now, mathematics and science students put the faculty to greatest use before examinations when the students have begun their cramming, and when for the first time they have learned enough to be able to ask questions - that is when the lines start to form outside the professors' offices. If the result of an open curriculum and the self-pacing that computerization permits is that students engage in a more even and sustained effort, and if the result is also that they take their examinations in a staggered fashion, the chief effect on the faculty might be that students begin appearing at the professors' doors in a less overwhelming but steadier stream throughout the year, and that in certain disciplines, voluntary individual consultations might replace lectures as the primary mode of faculty-student interaction.

BENIFITS ARE NUMEROUS

From the point of view of the student, the benefits of a computer based open curriculum are so numerous and so weighty as to make the option irresistible. The student's time is no longer wasted travelling to and from, and sitting in, a class where she learns nothing. She is relieved of the guilt and demoralization that result from being made to feel stupid many hours each week listening to incomprehensible lectures. She gains the security of knowing exactly what it is that she is responsible for learning, and she does not spend time learning things that are not examinable while neglecting to learn things that are examinable. She is able at every stage to pre-evaluate herself so that she always knows where she stands. She is freed of the fear of examination by ambush. Following every problem that she works out and every examination that she takes, she has an immediate and error-free feedback. She is not plagued by errors in her notes and in exercise problems and examination questions. She is not corrupted by seeking unfair advantages nor does she have her class standing lowered by other students who succeed in gaining unfair advantages. She is able to pick up where she left off following some interruption in her studies, and able to complete courses early. Because she no longer pays for lecture halls and lecturers which do not benefit her, her tuition fees drop. Because the university's costs fall too, it is able to provide her with finer libraries and better equipped laboratories. By the elimination of scheduling conflicts, she has a wider selection of courses, and by scheduling her own examinations, she avoids examination timetable clashes and inconveniences. Perhaps most important of all, she is relieved of the burden of every day having to pretend that the king is wearing clothes.