Small Groups: An Alternative to the Lecture Method

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Before you start reading this article take a moment to remember your most pleasant learning experiences. Did many of them occur while listening to a lecture? The hundreds of responses I have received to this question include very few reports of pleasant learning experiences taking place while listening to a lecture. The absence of such memories is especially significant since so much of a student's time in school is spent listening to lectures.

I will start by confessing that I have always been vaguely dissatisfied with the lecture method of teaching mathematics. There is an aphorism that I've heard from several of my mathematics teachers. You have probably heard it, and perhaps even used it. It is: "The only way you learn mathematics is by doing it." Any mathematics instructor who takes this statement seriously, and I do, should consider following it with something other than a semester of lecturing.

Another incident which indicated to me that the lecture method might not always be the most effective method to help students learn occurred when I was a graduate student. I asked a faculty member about an undergraduate course he was teaching and he said, "Well, I'm teaching a beautiful course but unfortunately the students just don't understand it." I've heard variations of that many times since then and have certainly felt that way about courses I was teaching.

There are alternatives to the lecture method. The purpose of this article is (i) to present some thoughts about the nature of learning[1] and (ii) to describe an alternative to the lecture method which is in accord with these ideas. I have found a small group approach quite effective in providing an *enjoyable learning* experience for students. (Both "enjoyable" and "learning" are important here. There is good reason to expect that students can participate in a classroom experience that is enjoyable and results in learning.) It should be made clear that I am not advocating

[1] Further explanation of some of these ideas can be found in "The Nature of the Learning Process" by Harvey Jackins (Rational Island Publishers, Seattle, Washington).

this method as the only way to teach. It is offered as a possibility to teachers who would like to experiment with a different approach.

First of all I want to start with a definition. (Would you expect anything else from a mathematician?) My definition of learning might be different from your definition of learning, but as a mathematician you will accept my definition for the purpose of this discussion.

Learning consists of evaluating new information in relation to information that's already understood and storing it in a form that's available for use in new situations. The second part of the definition is essential. A lot of the so-called learning (actually rote memorization) that our students do—that certainly we have all done in order to make it through our system—would not be learning according to the above definition. I'm sure you've all had the experience of giving students A's in one course and a semester or two later finding that these students cannot use the information that you thought they learned. Perhaps you have even experienced that yourself. You try to understand some mathematics or do some research and find certain information you thought you understood is not available for recall. The above definition of learning is concerned with learning of the kind that a young child does, for example, when he learns to walk, or to talk, or to use numbers. The information is assimilated and it's available.

I'd like to state briefly some assumptions about learning that are relevant to classroom teaching. These are only hypotheses about learning, but they are in accord with my experiences.

First, *learning is fun.* Remember, my definition of learning. Rote learning is not fun. I became convinced that learning is fun by teaching mathematics to some third graders and by observing my own children learn. Many people have made the same observation. John Holt summed it up well when he said that the main ingredient of genius is playfulness. Learning is something that we do naturally and joyfully. It is not and should not be tedious. If you look at a young child learning, he's enjoying himself. Young children enjoy playing with mathematics. I think the way that people approach mathematics could be and should be one of playfulness and joy in experiencing new ideas. No one should be forced to learn. We are all naturally curious. Aristotle's observation, "It is the nature of man to desire to know," is still valid. Learning is an essential part of our humanness, and it is enjoyable.

The second assumption is that *students learn best from someone they know and like.* The difficulty in accepting new information and ideas which challenge our old patterns of thinking is eased if we know that the person who is communicating with us knows us and cares about us.

Third, *it is easier to learn from peers than from someone in authority.* The comments I receive from students, when using peer teaching in the classroom confirm this assumption. It is probably fear that interferes with the student's understanding of information when it is presented by someone in authority.

The fourth assumption is that *learning is most effective when one person is teaching one other person (one-to-one learning).* I think there will be wide agreement with this assumption. I hear repeatedly from teachers that their students would

learn better if the class were smaller. What they are articulating is the difficulty of communicating information to many individuals at the same time. In a one-to-one learning situation the teacher can respond to that particular individual's problems. This assumption doesn't mean that you can't learn in other situations. We've all learned a lot in classes or by ourselves. What it means is that one-to-one learning is most effective. The obvious consequence of assumptions 3 and 4 for classroom teaching is that we use students to teach each other. It is obvious that an instructor can't teach even 20 students on a one-to-one basis. There isn't enough time. What an instructor can do is provide the situations where one-to-one learning can take place.

Assumption five is that *new information can only be evaluated when its relationship to information already assimilated is understood.* To achieve this, new information has to be presented in context and at the proper rate. If the information is presented out of context or too fast, the student is not going to be able to handle it and will get lost. Also if the information is presented too slowly the student is going to be bored. My experience in lecturing has been that no matter how hard I try, some of the students are bored because I am going too slowly and some of the students are completely lost. The percentages vary, but the evidence, from looking at their faces, is unmistakable. This points out one of the main problems of the lecture method. It is impossible to present all the information at the right rate for every individual student.

The sixth assumption is that *learning is facilitated by the learner communicating his knowledge.* By explaining a concept to someone else, an individual increases his understanding. Many teachers report that they did not really understand a subject until they taught it.

The seventh assumption concerns the student as a human being with feelings, rather than the cognitive aspects of learning. However, I think it is an extremely important assumption and one that is often overlooked in our desire to teach effectively the subject that we find so beautiful. The assumption is that *students who are feeling bad will not be able to give their full attention to learning new information.* The cause of the bad feelings is irrelevant. Whether they are upset because of not understanding the new information or because of emotional problems from outside the class (supply your own examples here), they are not going to be able to give their full attention to learning. The implications of this assumption for our teaching are profound. We cannot ignore our students' feelings. Since their feelings affect their learning we must, as teachers, attempt to deal with their feelings so as to free their attention for learning.

I am not suggesting here that we become therapists or counselors. I suggest only that in our role as teachers we are responsible for assisting our students in maximizing the attention available for learning new information. Some suggestions on how to do this will be given later in this paper.

I will now describe a small group approach to teaching mathematics which is in accord with the above assumptions and which I have found effective. I am not suggesting that this approach is the only method that is consistent with the seven assumptions and should be universally adopted. I only offer it as a suggestion to

those instructors who are dissatisified with the lecture method and might want to experiment with a different approach. I divide the class into groups of three to five students. I think four is best. I suggest two possible methods for selection of the groups: (i) heterogeneous grouping according to mathematical background or previous demonstration of mathematical ability; (ii) random grouping with regrouping every three or four weeks. Homogeneous grouping on the basis of mathematical background or previous demonstration of mathematical learning ability would introduce some complications and I advise against it unless some provision is made to provide additional instruction (perhaps using advanced students as assistants) for the weaker groups.

There are several possibilities for presenting information to the student. Ideally, study guides would be written with the small group approach specifically in mind. A writer of such guides would pay particular attention to the sequential presentation of new information interspersed with questions and exercises for group discussion. Another possibility is to use a standard text and write up very brief study guides directing the student's attention to important concepts and posing questions and problems for group discussion. Thirdly, a text could be used as a reference only, with study guides either (i) consisting of a series of questions aimed at proving a certain result or (ii) consisting of a set of problems for discussion. There are certainly many other variations. Whatever method you use for the presentation of the material, I suggest you provide some guide as to the amount of time the class is to spend on a particular subject. The groups tend to get very involved in discussing particular concepts to the exclusion of others.

During the class each group discusses the concepts and exercises in the study guides or text. The teacher circulates among the groups, observing, asking questions and explaining difficult points. I lecture to the entire class periodically—it probably averages about 30-40 minutes per week. In my lectures I summarize the concepts, offer some historical insight and attempt to provide some perspective for the new concepts they've been working with by putting them in context with what they've already learned and where they are headed. I avoid giving detailed proofs.

As far as grading is concerned, the group approach is compatible with any evaluation system. I use take-home problem sets since, in my opinion, this provides a reasonable evaluation of what I hope the student will learn.

The small group approach can be used in small classes of fewer than thirty students and in larger classes with the aid of a teaching assistant. It is important to remember that the function of the instructor using this approach is to facilitate learning and to be a resource person. The students will learn from each other and the written information.

It is clear that the small group approach provides a learning environment which is quite consistent with the assumptions mentioned earlier. The students report that it is fun to sit down with other students and talk about mathematics. Would not most mathematicians agree that it is more enjoyable to talk about mathematics with peers than to listen to someone else talk about mathematics to them? I was curious about student attitudes to personalized instruction and therefore asked one class, "Would you prefer to use a system of personalized instruction, where

you study by yourself, and the study guides are written for the individual?" Almost all of them said no. They enjoy talking to each other about the mathematics. The students became very supportive of one another, helping each other learn mathematics both in and out of the classroom. Also, there is a lot of peer teaching on a one-to-one basis. Frequently when one student has a problem with a particular concept he will be assisted by another student while the rest of the group discusses another concept.

I think that the most significant contribution of the group method to learning is that it allows the student considerably more control over the rate at which new information is being introduced than does the lecture method. If a student doesn't understand a particular concept he is much more likely to ask a question of a peer in a small group than he is of a professor in front of a class. I'm sure you have had the experience of asking for questions and receiving none, until you dismiss the class and start to leave. Although sometimes the group has to wait for my visit to get the question answered, usually someone in the group is able to answer the question or at least is willing to try.

It is in regard to assumption seven that the small group approach excels. First of all, in the group method the students are talking to each other. This, in itself, provides some relief from the feelings of loneliness and isolation that are common among students. Secondly, the group approach provides more immediate feedback to the learner and thus a successful learning experience is quickly recognized. This successful learning experience helps the student feel better and frees even more attention for learning. Thirdly, the classroom situation provides the flexibility and the freedom for the instructor to relate to the individual student as a human being. The instructor can validate the student's effort and experiences. Also, I often take a few minutes and have the students tell about some recent good experience in their lives or about a memory of a pleasant learning experience or something they like about themselves. All of these experiences, and similar ones you can think of, are designed to take the student's attention away from any distress he may be feeling and free his attention for learning. By participating in these activities the instructor gets to know his students and they get to know him. It is also important that the students learn each others' names, so have them introduce themselves to each other at the first few meetings. Fourthly, by encouraging personal contact between the instructor and the student, the group approach increases the instructor's awareness of the individual's learning difficulties and facilitates the process of providing the necessary support and encouragement.

Now a note of caution. Although the small group approach is effective, it is not without its challenges. The American educational system does not prepare students for active and cooperative learning adventures. The preconceived notion that one can only learn from an authority needs to be overcome, as well as the reluctance of students to risk asking questions of each other. In order to facilitate the transition to this method of teaching, I distribute a sheet of suggestions to students. This is included at the end of this article and you have my permission to reproduce it.

If the instructor explains his thinking about learning and provides encourage-

ment for the students when they do experience some difficulty, the group approach will provide both an enjoyable learning experience for your students and an enjoyable teaching experience for you. One particularly articulate and poetic student in an upper division abstract algebra class summed it up well: "Often times in the small group, questions would arise that we would pursue as a group and in the process of answering these questions, we would travel all sorts of universes. Such a spontaneous approach to learning, as often was the consequence in our group, provides knowledge of a degree that I feel will never leave me. This kind of knowledge is what makes life worth while for myself. The group method is by no means perfection, but it is a step in the right direction for it better taps the creative energy that is within... ."

REMARKS TO STUDENTS LEARNING MATHEMATICS IN SMALL GROUPS

Successful evaluation of new information requires that it be presented so that its relationship to information already assimilated is understood. A useful tool to insure that new information is presented *to you* in context and at the appropriate rate is "asking questions."

In addition, "asking questions" is a basic tool of mathematical research. Very simple questions about a situation can lead to very interesting results. I seem to recall a famous mathematician once said: "A good question is worth a thousand answers." If no one has said it, they should have.

I urge you to take the responsibility for asking questions about situations you don't understand or about those you would like to learn more about.

I offer some suggestions for encouraging question-asking in your group. If you think of any others, let me know about them.

1. Do not evaluate or criticize a question. Respond to it cheerfully.
2. Verbally appreciate the person who asks the question.
3. Validate each other's intelligence and ability to ask questions.
4. If you see someone is lost, encourage him/her to ask a question. Or ask a simple question of that person to bring him back to the group.
5. Ask questions yourself. Be a model for the entire group.
6. Try explaining something by asking a series of simple questions. (This is often more effective than just telling someone the answer.)
7. Remember that the facts are not so important as the process of investigation and communication that is taking place.
8. Smile and be cheerful. It will make it easier for someone to ask you a question.
9. Come on time.
10. Come prepared. This doesn't mean knowing all the answers. It means knowing what questions you have.
11. Approach the group each day with the idea that you are going to be responsible for (a) helping everyone else to learn, (b) asking interesting questions, and (c) making the experience an enjoyable one.

Learning is enjoyable. Remember what it was like when you were three years old? If you don't, observe a young child exploring his environment. Learning can be just as enjoyable for you.

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