Introduction

In this article, four different teaching approaches used during a mathematics tutorial of a first year undergraduate class to computer scientists will be given. The four approaches were each implemented in an attempt to keep non-mathematicians interested in mathematical topics. It was found that "Chalk and Talk" was not the best form of imparting knowledge to the students in the group. The duration of each tutorial was two hours.

The teaching strategies used were:

a. A class quiz;

b. Group explanation of material to members of the individual’s group;

c. Group explanation of material to members of the entire class; and,

d. Students teaching at the front of the class.

Each of the methods will now be discussed with the relative merits and defects included for a comparison. It was found that each method worked better at the end of each module, i.e., when the students were more familiar with the topics introduced on the module.

1.1 Class quiz

In order to determine members of each group, the author nominated four so-called captains and each captain took it in turns to choose a member for his/her group. To determine which captain started first a coin was tossed. During the tutorials, it was found that there were at most four groups with four members in each group.

Once the groups were determined, each group had to prepare two questions for each of the other groups to pose them as exercises. The questions could be taken from the class notes or any of the recommended text books for the module. Both the Posing Team (the team setting the questions) and the Attempting Team (the team answering the questions) were permitted to use the class notes. The scoring for the quiz was as follows:

Rules of the quiz:

• If the posing team could solve the particular problem, they were awarded one mark;

• If the team attempting the question could also solve the problem, then the Attempting Team was awarded one point (the Posing Team was still awarded one point);
If the team attempting the question could not solve the problem, then the Posing Team was awarded two points and the Attempting Team no points; and,

For a question to be allowed, the Posing Team had to be able to solve the question set, this was determined before the quiz began by the author.

An example of an actual set of questions set by a particular Posing Team and the respective scoring is shown below:

**Question 1)** The weight of a sample of patients being treated were measured and found to be 103, 127, 96, 110, 115, 72, 97, 134.

i) Find the sample mean and standard deviation;

ii) Find a 95% confidence for the mean \( \mu \);

iii) Find a 90% confidence for the mean \( \mu \);

iv) Compare the widths of these intervals; and,

v) Do the confidence intervals of ii) and iii) contain the value 100?

Other typical questions were:

**Question 2)** If \( A = \{1,2,3,4,5\} \) and suppose \( R = \{(1,1), (1,2), (2,2), (2,3), (3,3), (4,4), (5,5)\} \) then what type of relation is \( R \) on \( A \)?

**Question 3)** Determine \( \int \frac{2x}{\sqrt{x^2 + 2}} \, dx \).

**Question 4)** Prove De Morgan's laws.

**Question 5)** If \( A = \{1,2,4,6\} \), \( B = \{2,3\} \) and \( C = \{1,2\} \) find \((AXB)XC\) where the \( X \) denotes the Cartesian Product. Note the set will contain ordered triples \((a,b,c)\) where \( a \in A, b \in B \) and \( c \in C \).

**Question 6)** Find the general solution of:

It was found that this method of learning was immensely popular with the students, instilling a sense of teamwork. The author had to ensure that student enthusiasm during the competitions was within an acceptable level, as student debates became extremely animated. This method of learning allowed the author to determine the level of each team and to get "a feel" for what parts of the module the students found difficult, as these module topics tended to be used for questions set by the Posing Teams.

**Sample results**

Table 1 shows a set of results from an actual tutorial for teams labelled A, B, C and D, where Team A was the Posing Team:

For the sample results Team A was posing the questions and thus had the greatest total. Each team took turns to pose questions and the overall totals were determined.

<table>
<thead>
<tr>
<th>Question</th>
<th>Team A</th>
<th>Team B</th>
<th>Team C</th>
<th>Team D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>3</td>
<td>2</td>
<td>0</td>
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<tr>
<td>4</td>
<td>1</td>
<td>1</td>
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<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1 – Sample results from class quiz

1.2 Group explanation of material to members of the individual’s group

Using this approach, the author put the students into groups and asked members of the group to nominate another member of the same group to discuss and explain parts of the lecture that they had attended during the week or previous weeks. This worked well with the members of the group that were comfortable reporting back to their peers. The author went round to as many groups as possible during the session to listen to explanations given by individuals of each group.

1.3 Group explanation of material to members of the entire class

Using this approach, members of a group explained a particular topic to the entire class; the students did not approach the front of the class but remained at their desks and a "joint" discussion of a particular mathematical topic was given. This turned out to be extremely fruitful as even the apparently weaker students were able to make a contribution during the feedback period.

1.4 Students teaching from the front of the class.

Using this approach allowed for volunteers to come to the front of the class to deliver/explain part of the previous lecture or lectures of previous weeks to the remainder of the class. This worked well with those students that were comfortable talking at the front of the class and of course with those students that were sufficiently competent/knowledgeable with the material delivered in the lecture. On no occasion was a student invited to the front of the class by the author, i.e., only students who wanted to come to the front did so.

Topics that seemed to be popular were:

- discussions on solving linear/quadratic equations;
- discussions on graphs;
- discussions on matrices/linear algebra; and,
- discussions on the normal distribution.

Topics that were not popular and in which very few volunteers approached the front of the class were:
discussions on relational algebra;
discussions on set theory;
discussions on differential calculus; and,
discussions on integral calculus.

Encouraging this style of teaching enabled the author to determine the level of those students that chose to report back to the group. Of course, it also became clear which topics were the most challenging for the students, i.e., for the unpopular topics, on some occasions there were no volunteers to report back to the group.

2 Discussions

Four methods of teaching have been discussed in this article. Each method had definite positive and negative aspects. These will be summarised in Tables 2-5.

Class Quiz

<table>
<thead>
<tr>
<th>Positives</th>
<th>Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attempting Team worked well together to solve problems set.</td>
<td>The Setting Team generally had all questions set by the most able of the group; the less able students did not participate.</td>
</tr>
<tr>
<td>Knowledge shared by members in both the Setting and Posing Teams.</td>
<td>Students occasionally wanted “Chalk and Talk” sessions from the lecturer, especially when a new and difficult topic had been discussed in the previous lecturer. Thus students thought more specific learning took place during a “Chalk and Talk” session.</td>
</tr>
<tr>
<td>Able to look over all module notes and thus continually revise material.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Positive and negative aspects of class quiz

Group explanation of material to members of the individual’s group

<table>
<thead>
<tr>
<th>Positives</th>
<th>Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reporters demonstrated their knowledge and enhanced their own as well as their colleagues’ knowledge.</td>
<td>The more reserved and shy students did not participate in this approach and were often left feeling left out.</td>
</tr>
<tr>
<td>Knowledge shared by an able member of the team.</td>
<td>An exercise in which the more able students excel and the less able feel intimidated.</td>
</tr>
</tbody>
</table>

Table 3 – Positive and negative aspects of group explanation of material to members of the individual’s group

Group explanation of material to members of the entire class

<table>
<thead>
<tr>
<th>Positives</th>
<th>Negatives</th>
</tr>
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<tbody>
<tr>
<td>Even less able students reported back to the class.</td>
<td>More dominant personalities overwhelmed the less outgoing members of the group.</td>
</tr>
<tr>
<td>Knowledge shared by many members of the tutorial group.</td>
<td>Less able and shy students felt left out.</td>
</tr>
</tbody>
</table>

Table 4 – Positive and negative aspects of group explanation of material to members of the entire class
Students teaching at the front of the class

<table>
<thead>
<tr>
<th>Positives</th>
<th>Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to determine the exact level of an individual member of the group.</td>
<td>Appropriate to only the outgoing members of the class.</td>
</tr>
<tr>
<td>Knowledge shared predominantly by the most able student of the class to</td>
<td>Not many students volunteered to report back to the class at the front of the class, hence this teaching approach could not be used for the entire two hours.</td>
</tr>
<tr>
<td>his/her peers.</td>
<td></td>
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</tbody>
</table>

Table 5 – Positive and negative aspects of Students teaching at the front of the class

3 Conclusions

In this article, different teaching strategies utilised during tutorial sessions have been discussed. Due to the very nature of the approaches adopted no one approach was exclusively used during any particular session. It was found that in most cases:

1. **Group explanation of material to members of the individual’s group**
2. **Group explanation of material to members of the entire class.**

could be combined in a tutorial session and were found to work well.

The **Class quiz** could be used for the entire two hours.

The method of **Students teaching from the front of the class** was generally adopted to implement a different teaching strategy in the tutorial and to break up routine, especially during sessions in which students attempted questions individually at their desks.

Other teaching strategies are discussed in Ashcroft [1] and Rogers [2].

References


Editorial Comment

If you have tried a selection of teaching and learning techniques and you would like to write an article to share your experience with the wider MSOR community, please express your interest by emailing the editors at: editors@mathstore.ac.uk.