

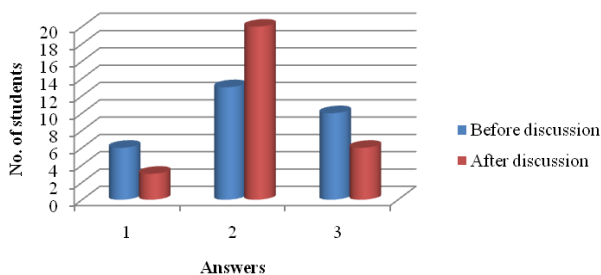






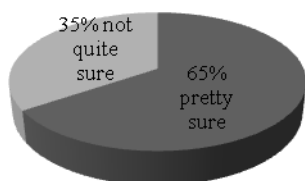


**Before and after discussion**

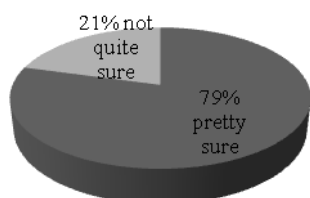


**Fig. 5.** Data analysis of responses to the question of Figure 1. Correct answer is 2.

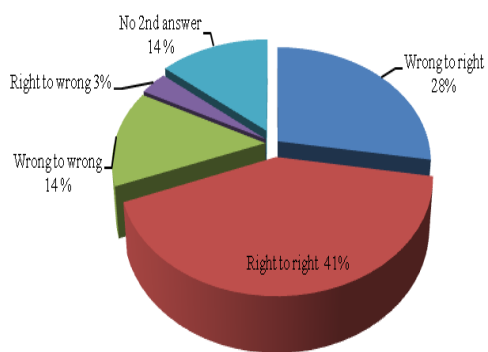
**Before discussion**



**After discussion**



**Fig. 6.** Confidence levels that characterized students' responses before and after the discussion.



**Fig. 7.** How answers were revised after convincing the neighbours through discussion.

The systematic effort to persuade their neighbours with the help of discussion increases the percentage of correct answers and student security for the chosen response. Usually, the improvement is greater when the initial response rate is about 50%. This is because the auditorium has more students able to convince others of the correct answer. Figure 6 shows how students have revised their responses after discussion. About 28% of them have reconsidered the wrong answer correctly, while only 3% of them have revised the answer from the correct one, in the wrong. Apparently, students are more efficient than the

lecturer, to explain the concepts to each other. Also, it is easier to change the mind of a student who has chosen the wrong answer than the one who has chosen the correct answer.

Half of the course was subjected to Peer technique, while the rest continued the lecture in the traditional way. In the middle of the semester, all course students underwent the Concept Test. The summarized results are given in Table 2 and Figure 8.

**Table 2.** Evaluation in scores for the part of students where we used and did not use *Peer Instruction*.

Corresponding scores (max. 30 scores)	No. of students for corresponding scores. The part where Peer instruction was used	No. of students for corresponding scores. Traditional method
1	0	0
2	0	0
3	0	0
4	0	0
5	0	1
6	0	2
7	0	2
8	1	1
9	2	1
10	1	3
11	1	1
12	1	1
13	1	1
14	0	2
15	1	2
16	2	1
17	3	1
18	3	1
19	2	1
20	1	0
21	0	2
22	1	2
23	2	1
24	1	1
25	0	1
26	1	0
27	1	0
28	2	0
29	0	0
30	2	0

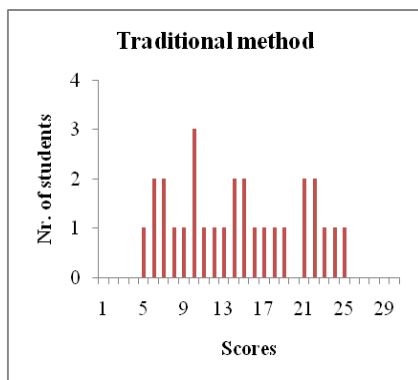
What is noted is a shift of the average score per student from 14.1 points for (a) to 18.7 points for (b). The change is most noticeable for a large number of students [6-8]. Anyhow, under our conditions, it is very enjoyable.

*Seminars*

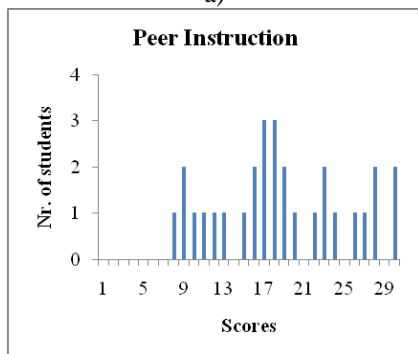
The results of the students, as the first part, where we applied the problem-solving scheme, and the second part, where we did not apply it, are summarized in Table 3.

**Table 3.** Percentage of students with structured solutions for two problem-solving methods (solution scheme vs. traditional approach)

Methods	% of students	Percentage of students with well-structured and well-argued solutions	Percentage of students with a moderately structured and argued solution	Percentage of students with no structured and argued solutions
Problem solving with a scheme		51.7%	31%	17.3%
Problem solving using the traditional method		25%	32.1%	42.9%



a)



b)

**Fig. 8.** ConcepTest evaluation based on scores of students for traditional method vs. those taken from Peer Instruction.

The results show a higher percentage of students with structured and well-balanced

solutions from a conceptual point of view when applying a problem-solving scheme.

#### Laboratories

The results obtained in laboratories are summarized in Table 4.

Peer technique tracking significantly improves student performance in labs by 7.8% higher than the average of the group's estimation, which is not only lacking in traditional methods, but there is a decrease in the group's average of 4% from the initial estimate.

#### CONCLUSIONS

- The active participation of students in discussions with each other spoiled the inevitable monotony of passive lectures. It significantly improved their performance.
- Assimilation of information increased significantly compared to traditional methods.
- Immediate feedback is given to the conceptual understanding of students.
- Troubleshooting with the help of the scheme helps the conceptual learning process. Also, the logical organization of problem-solving stages expanded students' knowledge and made them applicable in new contexts.

**Table 4.** Evaluation at the end of semester for the two laboratory groups working and not working with the Peer Instruction

PEER INSTRUCTION			TRADITIONAL METHOD		
Students	Evaluation at the beginning of semester	Evaluation at the end of semester	Students	Evaluation at the beginning of semester	Evaluation at the end of semester
Stud. 1	9	10	Stud. 1	5	5
Stud. 2	7	9	Stud. 2	10	9
Stud. 3	7	7	Stud. 3	7	7
Stud. 4	8	9	Stud. 4	6	6
Stud. 5	10	10	Stud. 5	8	7
Stud. 6	5	6	Stud. 6	9	9
Stud. 7	7	8	Stud. 7	7	7
Stud. 8	8	8	Stud. 8	8	7
Stud. 9	9	9	Stud. 9	8	8
Stud. 10	9	9	Stud. 10	5	5
Stud. 11	6	6	Stud. 11	10	9
Stud. 12	7	7	-	-	-
Mean	7.6	8.2	Mean	7.5	7.2
Standard deviation		1.34	Standard deviation		1.4

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