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Didactic methods of teaching physics at "Fan S. Noli" University in Korca

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Didactics, once valued as the art of a teacher, is today an established science with properly defined laws, regulations and methods. Considering the actual needs of our schools, the studies concerning the scientific approach of the didactic methods of physics take central priority. The pedagogue at the “Fan S. Noli” University of Korca has put himself up to the selection of the most efficient forms and methods of conveying the concepts of physics to students with different backgrounds, who study the subject of physics for one semester. This article examines the factual aspects of applying *just in time teaching method (Peer Instruction)*, using *ConcepTest* and solving *strategy/scheme* for problems, intertwined these with *group studying method* regarding the subject of physics (this includes lectures, seminars and lab work). The results derived, demonstrate an increased efficiency of the new teaching practices, compared to the traditional ones from two years ago. This is clearly manifested in the increased collaboration between students and teachers when discussing about the subject of physics. Finally, an increased conceptual scale is being evidenced, along with higher results/evaluations than two years ago.

Keywords: Just in time teaching, Peer Instruction, ConcepTest, Solving scheme, Group studying.

METHODOLOGY

It includes two basic steps of the teaching process [1]:

- *Transfer of information* - an indispensable step in the classroom, where information is passed to the student through the lecturer.
- *Logical assimilation of information* - an even more important and indispensable step for the sake of truth. It is realized outside the classroom. Some of the students achieve this step in an autodidactic way, while others do not do it at all.

Based on the degree of difficulty in the realization of these two steps, efforts have been made to realize the transfer of out-of-class information and the assimilation of information within the classroom. In this way, we are disconnected from the traditional way of teaching to give way to the modern method (JiTT, Peer Instruction).

The tactics of organizing cooperative lectures

Students are assigned to read in advance the material to be handled in the next lesson (transferring information to them is done out of the class not through the lecturer but through the book).

Example: After the initial reading that the students made to the chapter on the Conservation Laws in the lecture, it is discussed (*ConcepTest*):

- A cube slides without initial velocity in the corrugated and polished gutter as in Figure 1 [2].

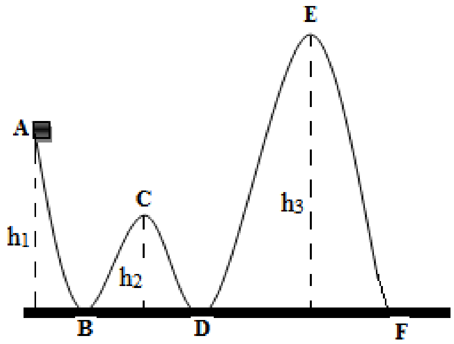

Fig. 1. The corrugated and polished gutter

1) The cube passes the C and E obstacles and reaches point F;

2) The cube passes the C but not the E obstacle;

3) The cube fails to pass even the C obstacle.

- How is the cube velocity at the lowest culvert?

1) The cube velocity at points B, D, F is the same;

2) The cube velocity at points B and D is different;

3) The cube velocity at points B and D is the same.

This is the most appropriate phase to apply Peer instruction, which includes students and lecturer in the cycle below as shown in Figure 2.

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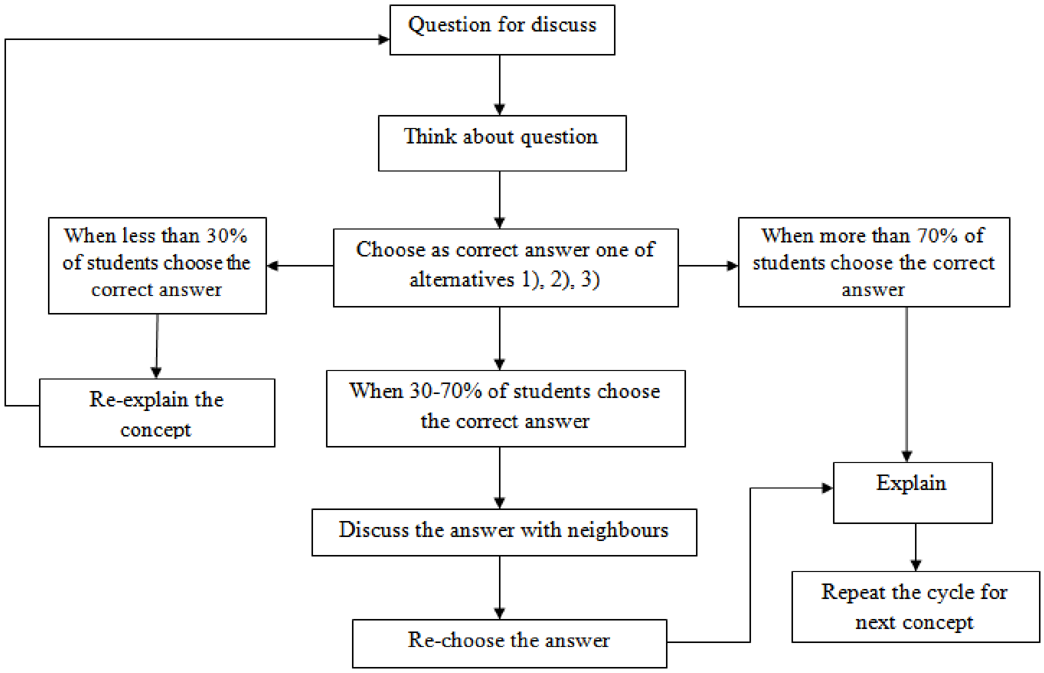


Fig. 2. The cycle of Peer Instruction

Problem solving tactics (seminars)

Problem solving cannot be independent of the concepts and principles taught. It is important when solving problems to form the kind of knowledge to the student so that he can apply it in a new context. To achieve this goal, the lecturer himself pursues a model procedure for solving a particular problem. Schematically summarized, the scheme / solution strategy [3,4] of the problem is given below in Figure 3:

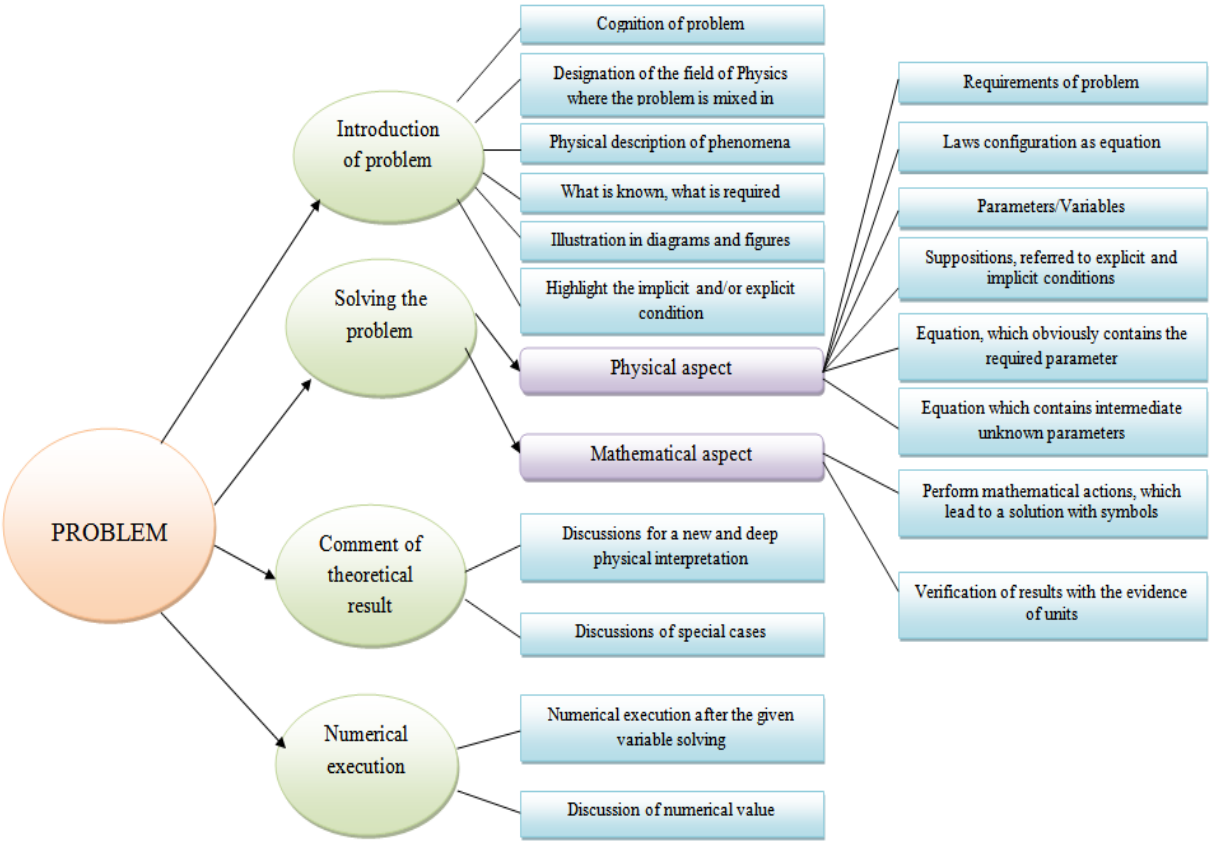


Fig. 3. Strategy/scheme of solving problems

Having solved a problem by following the model described above, the lecturer gives another problem to be solved. Classes are organized in small workgroups with 3-4 members each and are encouraged to give ideas (within the group) to solve the problem. The choice of each group is considered, checked and evaluated which of the groups has the most structured solution (according to the model scheme) and the opportunity is given to the members of that group to discuss with others on the blackboard their way of solving the problem.

Example: A parachutist, the first 45 m after launch, without initial velocity, from a bridge, did not open the parachute. After its opening, his motion became evenly changed with acceleration, 2.5 m/s^2 until he reached the ground with velocity of 2 m/s. Assuming that all his motion is in a straight line, it must be calculated:

- How long did the parachutist stay in the air?
- From what height did he jump?

Introduction of problem

✓ *Cognition of problem*

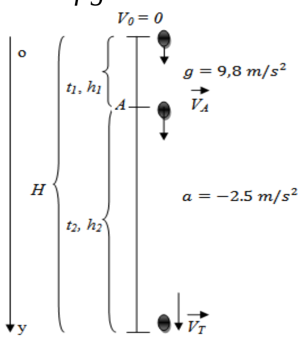
1. Parachutist crosses h_1 = *45 m* of height without opening the parachute.
2. After 45 m he steps up the parachute and his motion begins to slow down with acceleration a.
3. He keeps this motion until he reaches the ground with velocity v_T.

Is required to calculate the total flight time of parachutist t_p.
Is required to calculate the height from which the parachutist jumped H.

✓ *Designation of the field/s of physics where the problem is mixed in*

- free falling
- linear motion
- velocity
- acceleration/free falling acceleration
- velocity and height equation
- vertical axis

✓ *Illustration figure*



oy - Is chosen as positive axis of motion

✓ *Approaches*

The motion from the moment he jumped till he reaches the ground, is considered as linear motion.

Solving of problem

<u>Is required</u>: total flight time of parachutist t_p,.

<u>Condition:</u> h_1 is crossed with free falling without initial velocity and h_2 is crossed with negative acceleration.

<u>Known variables:</u> h_1, a, g, v_T .

(1) $t_p = t_1 + t_2$ (t_1,t_2) intermediate unknowns, where t_1 is found from the equation of that part of height which the parachutist makes with free falling.

(2) $$h_1 = v_0 t_1 + \frac{g t_1^2}{2} = \frac{g t_1^2}{2} \Rightarrow t_1 = \sqrt{\frac{2h_1}{g}}$$

because of $v_0 = 0$. The equation that contains the intermediate unknown t_2 is the velocity equation for that part of height that the parachutist crosses with acceleration $\vec{a}$.

(3) $v_T = v_A + a t_2$ (v_A - the velocity that the parachutist has achieved at the end of h_1 = *45 m* which serves as initial velocity for the second part of height h_2) intermediate unknowns.

(4) $v_A = v_0 + g t_1 = g t_1$ because of $v_0 = 0$. Now we have no more intermediate unknowns. Making substitutions we obtain:

$$t_p = \sqrt{\frac{2h_1}{g}} + \frac{v_T - \sqrt{\frac{2h_1}{g}}}{a}$$

<u>Is required</u>: H

<u>Condition:</u> He crosses h_1 with free falling without initial velocity and h_2 with negative acceleration.

<u>Known variables:</u> h_1, a, g, v_T . From the first part of solving are known: t_1, t_2 and v_A

(1) $H = h_1 + h_2$ (h_2) intermediate unknown, we can find it from the height equation:

(2) $$h_2 = v_A t_2 + \frac{a t_2^2}{2}$$

There are no more intermediate unknowns, after substitutions we achieve:

$$H = h_1 + v_A t_2 + \frac{a t_2^2}{2}$$

Executing numerical value

$$t_p = \sqrt{\frac{2x45m}{9.8\frac{m}{s^2}}} + \frac{2\frac{m}{s} - 9.8\frac{m}{s^2}\sqrt{\frac{2x45m}{9.8\frac{m}{s^2}}}}{-2.5\frac{m}{s^2}} \approx 14.3s$$

The parachutist stood about 14.3 sec in air.

$$H = 45m + 30\frac{m}{s}x11.3s + \frac{(-2.5\,m/s^2)x11.3s^2}{2} = 370m$$

The height of the bridge from which he jumped is about 370 m. Dimensional analysis convinced us for the correct solution of the problem.

Laboratory development tactics

Groups of 3-4 students each get acquainted with the specifics (construction of equipment, operation) of the lab's work that they will develop and prepare to measure.

Also, group members have theoretically prepared the lab work assigned to them and by Peer technique are encouraged to discuss what is required to measure and the variables they expect to derive.

Students cooperate in performing measurements by sharing tasks and discussing measurement compliance with what they are expecting to derive.

They argue their work and results in the classroom [5].

Example: Work No. 5. Energy Conservation Law. Maxwell's wheel

Maxwell's wheel (Figure 4), is located at *h* height from the potential zero energy level. It is released without initial speed. The end-of-turn velocity is expected to be:

1) greater;
2) smaller;
3) equal

to the velocity, when it is released from the same height without initial velocity, only under the force of gravity (air resistance forces are not taken into consideration).

Fig. 4. Maxwell's wheel

RESULTS AND DISCUSSION

Lectures

The number of students who underwent the concept test in the lecture example (Figure 1) was 29. The results of their responses are given in Table 1, Figures 5, 6 and 7:

Table 1. Distribution of the number of students according to respective responses before and after discussion. Confidence levels for the chosen responses.

BEFORE DISCUSSION					
Answers	No. of std for corresponding answers	Students pretty sure for the answer	Percentage	Students not quite sure for the answer	Percentage
1	6	3	65.5 %	3	34.5%
2	13	10		3	
3	10	6		4	
AFTER DISCUSSION					
Answers	No. of std for corresponding answers	Students pretty sure for the answer	Percentage	Students not quite sure for the answer	Percentage
1	3	2	79.3%	1	20.7%
2	20	17		3	
3	6	4		2	

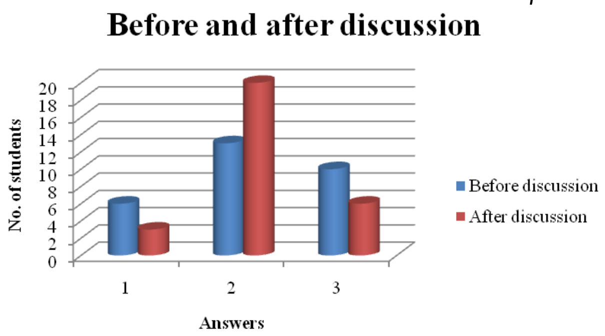


Fig. 5. Data analysis of responses to the question of Figure 1. Correct answer is 2.

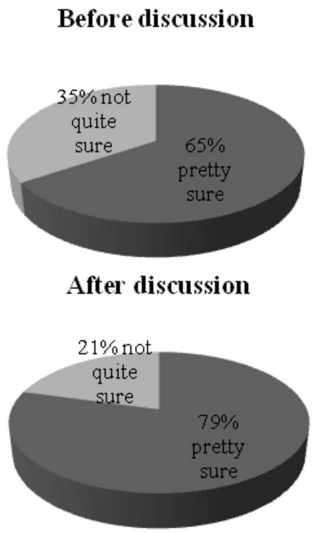


Fig. 6. Confidence levels that characterized students' responses before and after the discussion.

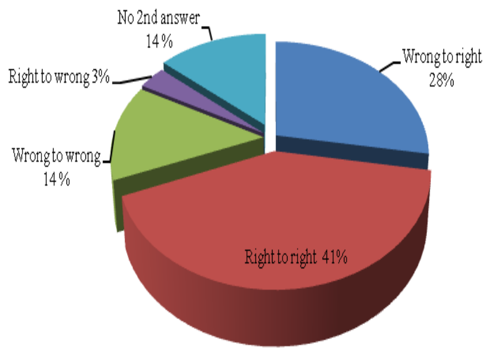


Fig. 7. How answers were revised after convincing the neighbours through discussion.

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

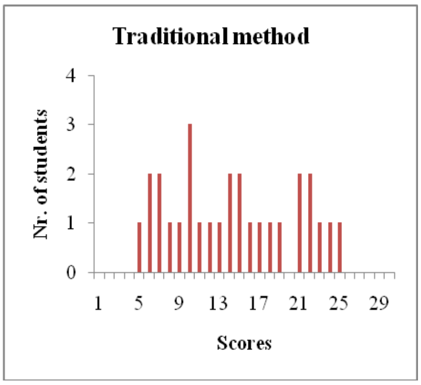
What is noted is a shift of the average score per student from 14.1 points for (a) to 18.7 points for (b). The change is most noticeable for a large number of students [6-8]. Anyhow, under our conditions, it is very enjoyable.

Seminars

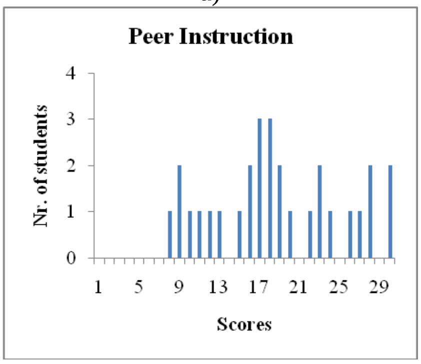
The results of the students, as the first part, where we applied the problem-solving scheme, and the second part, where we did not apply it, are summarized in Table 3.

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

% of students / Methods	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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