Implementation of problem based learning in cooperative learning groups: An example of movement of vertical shooting

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Abstract

It is emphasized that Problem Based Learning (PBL) and Cooperative Learning (CL) take part among one of the important implementations of active learning in physics teaching. Despite having paid attention to the positive affections of researches based on practicing in the subject of education, literature do not include developed source materials in the context of related researches at expected level.

The purpose of this research is to introduce developed activity by detailing gradually based on the principle of Cooperative Learning (CL) and PBL in the unit of ‘Motion on the Earth’ in the topic of ‘Movement of Vertical Shooting’ on physics course in the second grade of high school.

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1. Introduction

The traditional curriculum suffers from overloading students with an excessive emphasis on memorization. The PBL, as a means of developing learning for capability, is rather than learning for the sake of acquiring knowledge. The emphasis of PBL approaches is on learning processes of inquiry which proceed by asking what needs to be known, to address, and to improve a particular situation (Boud & Feletti, 1997). In this context, PBL provides practitioners a deep understanding of subject matter while developing higher-order thinking skills of students (Savery, 2006).

It is emphasized that Problem Based Learning (PBL) and Cooperative Learning (CL) take part among one of the important implementations of active learning in physics education.

Despite, conducting good PBL has difficulty, when the process is done successfully; teachers and students reach farther goals. In this context, PBL provides practitioners identifying and reflecting on students’ basic needs, affect both classroom behaviour and skills related to the roles and responsibilities in implementation process as individuals and as in groups (Osterman, 2000).
Although there are many descriptions about PBL, there is no guiding documentation related to its implementations or effective applications in physics teaching.

Despite, taking attention to the positive effects of researches based on practicing implemented in the subject of education, literature does not include developed source material in the context of related researches in expected level. For this reason, as developed source materials have not qualification to instructor for new researcher implementing similar studies, they do not use effectively in teaching process.

While education process is carried out by PBL based application in cooperative groups; cooperative learning based stages should be taken into account for the grouping and task sharing in terms of researching and implementing together within PBL. There are a variety of models about PBL and cooperative learning in literature. Researches are carried by PBL seven steps model (Table1). PBL seven step models is consisting of; clarifying, defining, analysis, reviewing, identifying, learning objects, self-studying, report and synthesis. The implementation of PBL seven steps model and the actualized activities are shown in Table 1.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td>Clarify</td>
<td>The students read through the problem, then identify and clarify any words, equations or physical concepts that they do not understand</td>
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<tr>
<td>Define</td>
<td>The students work together to define what do they think about the problem</td>
</tr>
<tr>
<td>Analysis</td>
<td>The students discuss or ‘brainstorm’ the problem. At this stage there is no prioritization or shifting of ideas</td>
</tr>
<tr>
<td>Review</td>
<td>Students now try to arrange their ideas and explanations into tentative solutions</td>
</tr>
<tr>
<td>Identify Learning Objectives</td>
<td>The group reaches a consensus on learning objectives, if necessary with the guidance of the facilitator</td>
</tr>
<tr>
<td>Self Study</td>
<td>Students individually gather information towards the learning objectives and prepare to share their findings with the rest of the group</td>
</tr>
<tr>
<td>Report and Synthesis</td>
<td>The students come together in their groups and share their results. The facilitator checks that the learning objectives have been met</td>
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Students’ learning goals may be structured to promote cooperative, competitive, or individualistic efforts. In contrast to cooperative situations, competitive situations are the one in which students work against each other to achieve a goal that only one or a few can attain. In competition there is a negative interdependence among goal achievements; students perceive that they can obtain their goals if and only if the other students in the class fail to obtain their goals (Deutsch, 1962; Johnson & Johnson, 1989).

Johnson’s (2003) eight steps model based on cooperative learning and the process skills in each step are shown in Table2.
Table 2. Stages of cooperative based learning model (Johnson, 2003).

<table>
<thead>
<tr>
<th>Steps</th>
<th>Activities</th>
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</table>
| Recognize the power of groups for assessment purposes | • Groups help to make assessment meaningful by involving students in helping each other to learn and to improve.  
• Groups provide the framework for involving students in the assessment process by having them assess each other's work.  
• Groups enable teachers to assess groups as well as the individual students. |
| Structure effective (not ineffective) groups | The second step is to structure cooperative learning groups (rather than traditional learning groups or pseudo groups) by including positive interdependence, individual accountability, promotive interaction, appropriate use of social skills, and group processing. |
| Make an assessment plan | Teachers must decide what to assess, what criteria and rubrics to use, how to sequence the instructional tasks and assessment procedures, and when to give feedback. |
| Use groups to assess individual performances | The basic purpose of a cooperative group is to make each member a stronger individual in his or her own right. |
| Assess group performances | Many assignments require groups to produce a single product, such as experiments, field projects, dramatic or musical productions, team sports, and so on. Such group products are assessed as a whole. In addition, many instructional procedures require a group product, such as problem-based learning, the case study method, group investigation, and academic controversy. |
| Structure peer assessment of group mates | Utilizing peers in assessment increases the learning of the assessor, allows for more frequent assessments to take place, allows for the assessment of a wider variety of outcomes, allows for the use of more modalities in assessment, reduces the bias inherent in making reading and writing prerequisites for assessment, allows for the utilization of more sources of information, reduces potential teacher bias in assessment, and creates peer social support systems for remediation and enrichment. |
| Structure self-assessment within groups | Cooperative learning groups provide the arena in which self-assessment takes place. Self-assessment leads to such outcomes as self-awareness and self-regulation, self-monitoring and appropriate self-presentation, self-understanding, and social sensitivity. |
| Use groups to create assessment situations | There are two major methods for doing so: Role-playing and simulations. Group experiences are very useful in assessing complex competencies and skills that need to be demonstrated as well as described. |

Cooperative learning groups on PBL can be used to teach specific content and problem-solving skills (formal learning groups), ensure active cognitive processing during a lecture (informal learning groups), and provide long-term support and assistance for academic progress (base groups). When used in combination, these learning groups provide an overall structure with variety for students (Johnson, 2007). The purpose of this research is to introduce developed activity by detailing gradually based on the principle of Cooperative Learning and Problem Based Learning in the unit of ‘Motion on the Earth’ in the topic of ‘Movement of Vertical Shooting’ physics course in the second class of high school. In addition to attract attention that, developed activity practice grade, confronting difficulties and all of the gain which grade.

2. Method

2.1. Research model

This research is implemented based on action research methodology. In this context, researcher took active role in all the phases of research process.

2.2. Sample

Research was applied with 15 students who are educated in 10th class in Trabzon Vakıfkebir High School in the
2.3. Development phases of teaching material and planning to implement

Teaching Materials in research are based on these phases:

1. Available researches and developed teaching materials are examined by reviewing the literature about PBL and CL.
2. An investigation is made concerning in which units and subjects on PBL we can develop teaching materials for CL in Physic lesson.
3. *The Likert type questionnaires are found about the attitudes and interests of the second grade of high school about the unit of ‘Motion on the Earth’ in the topic of ‘Movement of Vertical Shooting’ on physics course.*
4. Specified subjects and concepts applications on PBL are planned to make outside the classroom in appropriate places.
5. Required animations, texts, and shapes are planned for presentation programs by identifying animations and design programs relevant to research.
6. Recommendations of a painting teacher are considered about the colour matching.
7. Findings of observations and interviews of teachers and students are examined in the process of pilot scheme. Developed material is finalized by editing the adjustments.

2.4. Implementing the developed teaching material

The process of practicing of the study which is executed on scope of research is divided into five stages. 1) *Introducing the scenarios of the problem:* The questions and the scenarios of PBL that was prepared before were handed out to the students and presented on the computer with the projection device 2) *Detection of the conditions of problems:* The question of “What are the situations that may result with the problem on the scenario?” is asked on the inventory of the groups for forming the problem. 3) *The constitution of hypothesis:* The similarities and the differences between the groups on the skills of the detection and the definition of the problems are specified by observations and written evaluations. 4) *Finding out the lack of information:* The level of the students for written and oral- clearly-explanations of the problems was found out. 5) *Practicing of new learning:* The generalizations of the students’ groups are discussed and the consensus provided solutions are reported in the classroom.

Applications in the research process is implemented by developing the model of PBL implementations in CL groups consisting of seven step making use of implementation process of seven step model of PBL and eight steps model of CL.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activities</th>
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<tbody>
<tr>
<td>1. Giving problem scenarios</td>
<td>✓ Prepared PBL scenarios are presented to students by power point</td>
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<tr>
<td></td>
<td>✓ Oral discussion is made about whether the scenarios understood or not in an expected level.</td>
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<tr>
<td>2. Identifying problem situations</td>
<td>✓ Problematic situations in scenarios are implied by the groups.</td>
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<td></td>
<td>✓ The differences and similarities between the skills of groups on identifying and implying the problem.</td>
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<td>3. Hypothesis Formation</td>
<td>✓ Students searched for possible answers for problems.</td>
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<tr>
<td></td>
<td>✓ Students are encouraged for developing some answers even if they are not sure.</td>
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<tr>
<td></td>
<td>✓ Problem is divided into sub-titles and stages. (Clues are given when necessary).</td>
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<tr>
<td></td>
<td>✓ At the end of this stage, students expressed their ideas about the problem in written.</td>
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<tr>
<td>4. Identifying information gaps</td>
<td>✓ It is discussed that if the question has another answer or not.</td>
</tr>
<tr>
<td></td>
<td>✓ The answer, found by the group, is investigated by another different answer.</td>
</tr>
<tr>
<td></td>
<td>✓ The effort in unsuccessful solutions are not a frustration, it is discussed with students that; there can be some useful information in unsuccessful attempts.</td>
</tr>
<tr>
<td>5. Implementing new knowledge</td>
<td>✓ Generalizing</td>
</tr>
<tr>
<td></td>
<td>✓ The consensus solutions are turned into a report.</td>
</tr>
<tr>
<td>6. Abstraction</td>
<td>✓ The hypotheses are narrowed by the help of new information added to scenario.</td>
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<tr>
<td></td>
<td>✓ The groups shared the findings and results and also successful studies with their friends.</td>
</tr>
<tr>
<td>7. Evaluation</td>
<td>✓ The level of having adult role</td>
</tr>
<tr>
<td></td>
<td>✓ Group trying</td>
</tr>
<tr>
<td></td>
<td>✓ Studying independently skills</td>
</tr>
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</table>
The results of test questions at the implementation level are applied to pre-test group. After applying the pre-test, PBL applications were carried out in CL groups for 3 hours lesson during a week. After 4 years, within the research tests were applied to the groups and the results were analyzed. The test questions were prepared to identify theoretical information levels of students and association levels with the unit of Motion on the Earth’ in the topic of ‘Movement of Vertical Shooting’. Resourcing, and applying to experts and researches were encouraged, the education director instructors during the process. In observations, task sharing of students, interactions within the group, willingness of fulfilling duties, the other process skills were observed in Cooperative Learning groups according to PBL. An attitude questionnaire is conducted to identify the level of students commensally from related literature on the principle of Cooperative Learning (CL) and PBL in the unit of ‘Motion on the Earth’ in the topic of ‘Movement of Vertical Shooting’. For this reason; the questionnaire was conducted to students groups and the scenarios was prepared for the parts which were interested by the students.

### 3. Findings

After implementing the teaching material which is developed basically on the levels of the research application process, then, the developed teaching material is finalised by indicating the findings of the activities in related stages process. It is found out that students have behaved as daily routines and had definite solutions in order to obtain the solutions of the problems on scenario based PBL.

#### Table 4. Planning “The Movement of Vertical Shooting” for CL in PBL

<table>
<thead>
<tr>
<th>Part 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson</td>
</tr>
<tr>
<td>Class</td>
</tr>
<tr>
<td>Unit</td>
</tr>
<tr>
<td>Topic</td>
</tr>
<tr>
<td>Period</td>
</tr>
<tr>
<td>Student’ objectives and attitudes</td>
</tr>
<tr>
<td>Objectives:</td>
</tr>
<tr>
<td>Attitudes: 2. The students learn, how the substance moving vertical.</td>
</tr>
<tr>
<td>3. Determine the time it takes the object to fall from its highest point.</td>
</tr>
<tr>
<td>3. The students comment on graphics and tables of the movement of vertical.</td>
</tr>
<tr>
<td>Concepts of unit</td>
</tr>
<tr>
<td>Teaching-learning, methods and techniques</td>
</tr>
<tr>
<td>Used devices and technologies of education</td>
</tr>
</tbody>
</table>
Movement of Vertical Shooting
Düşey Atış Hareketi

Imagine that you joined the army as it was a duty. Since you are an engineer, you are serviced as the curator officer of rocket department of Project development centre. You are having difficulties with some kind of problems while testing rocket shooting. Here are some of them:

- While directly shooting upwards, the planes on the target flies away till your rockets get some certain height.
- As the planes fly on very high levels, your rockets cannot get the targets.
- When you use your rockets on different continents, they get the same targets on the same levels but on different times.

Firstly, having some solutions for these questions with your team, will be very useful for getting over your problems:

1) What kind of movement your rockets get?
2) What should you do to get your rockets raised more?
3) What is the reason for having time differences in different continents with the same rockets when you launched them straight above?
4) What kind of differences may we have if we have this rocket shooting on the Moon?
5) What kind of changes do you do in order to develop more appropriate shooting rockets?
6) How do you calculate the highest point that one rocket can reach?

Part II

Upward Path
- Velocity is upward
- Acceleration due to gravity is downward
- Since acceleration and velocity are in opposite directions, the object slows down as it moves upward

At Maximum Height
- Velocity has slowed to zero
- Acceleration is still present!
- Acceleration is changing the direction of motion

Downward Path
- Velocity is downward
- Acceleration due to gravity is downward
- Since acceleration and velocity are in the same directions, the object speeds up as it falls downward

\[
\begin{align*}
v & = v_0 + at \\
s & = \frac{1}{2}(v + v_0)t \\
s & = v_0t + \frac{1}{2}at^2 \\
v^2 & = v_0^2 + 2as
\end{align*}
\]
1 Giving Problem Scenarios
- PBL written scenario was delivered and also a power point presentation was shown to students in the classroom.
- Students groups were asked “What was intended to be told?” Students understood the scenario summary about Vertical Shooting Movement.

2 Identifying Problem Situation
- In creating group problem inventory students were asked “What are the problematic situations in this scenario?” The following answers were reached:
  1. What are the problematic situations in this scenario?
     - Whether condition
     - Air friction
  2. What are the other problematic situations in this scenario?
     - Air friction
     - Flow Through
     - Accuracy of data received from satellite
     - Calculators

Groups’ differences in skills of identifying and implementing the problems in scenarios was determined by observation and written evaluation.

Another group’s resolution suggestions
  1. What are the other problematic situations in this scenario?
     - Speed of rocket
     - Gravitation

3 Generating Hypothesis
- The second question of group inventory was answered as follows:
  - Calculating by taking into account of angular deviations
  - We should decrease force of friction and increase the speed
  - Rocketing ground should be concrete

Another groups’ resolution suggestions:

What are your resolution suggestions for the problems you found?
- I have to speed up the rocket
- I have to take into account of the gravitation while speeding up

- The problem was divided into sub-problems and titles and students were provided to focus on closer answers for the main subject.
At the end of this stage, it is determined that students identified the problem and expressed in written and orally.

**5 Identifying Information Gaps**

- The teachers provided students to come up with an idea about their answers whether true or not, and shown a film section by the help of projection.
- Whether the problem has another solution or not, was given in written and answers were taken orally. It was discussed in groups.

*What can it be the other solutions?*

"To make the rocket more durable for the pressure"
"Speed up the rocket"
"Shooting the plane by vertical shots instead of horizontal"

The answers of another group.

*What can it be the other solutions?*

"Speed up the rocket"
"The distance between the rocket and the target should be reduced"
"Speed up considering gravitation"

- Although students found unsuccessful solutions, it is expressed and found out from the discussions that students can learn something from their failed solutions and their studies did not go to waste.

**6 Implementing New Information**

Generalization of students groups discussed in the classroom.
Consensus solutions put into a report form.

**7 Abstraction**

Among the hypothesis, the invalid ones were removed considering newly added information.
The groups shared their results and successful findings with their friends.

**1. Assessment and Evaluation towards Individual Learning Activities**

- **The Level of Learning Concepts**
  It was examined that; how can the students’ acquisition and aimed behaviours, required by secondary education curriculum, be reached which is accepted by Board of Education and Discipline.
- **The Level of Having Adult Role**
  Students’ level of having adult role was determined by education instructor observations and by students with the help of questionnaires.

In order to develop feeling of confidence and skills for research; students used the internet, documents, experts, and they analyzed the findings from different resources besides the technique they used. Also they built hypothesis, test, discussed with other friends and benefit from their friends’ findings. This process taught them “Learning”.


2. Measurement and Assessment towards Group Work

- **Group Effort**
  Students' willingness and interest was identified by education instructor observations and by students with the help of questionnaires.

- **Skills of Implementing in New Situations**
  Different questionnaires were used in order to test whether the students used their knowledge in their social life or not.

- **Cognition of Circumstances which based problems' Basic Philosophy**
  While solving the problem, the high level cognitive and thoughts skills such as analysis, synthesis, and evaluation was identified to find which level were they developed by using different questionnaires?

3. The measurement and assessment activities for students who have difficulties in learning and students who have advanced learning skills

- **The ability of Identifying new Problems and Solving them**
  Students presented acceptable proofs concerning different problem circumstances.

- **The Ability of Self Evaluating**
  Students were provided to realize their own skills and they evaluated their own study.

- **The Ability of Evaluating their Friends**
  Students learned different democratic rules such as listening their friends and exposure to other ideas. It was found out that, students interaction between them were increased.

- **The Ability of Evaluating their Instructors**
  Education instructors' success of leading the process and increasing the quality of education was evaluated by students.

SECTION 3
Explanations of Implementing the Plan

The subject was taught in two hours.

1. It is appropriate for the 1.2551 “Tebligler” Journal basics.
2. It is prepared considering from the unit of “Motion on Earth” in high school curricula which was accepted numbered 128 by Board of Education and Discipline on 1st May 1992

4. Conclusions

On the practicing of PBL in CL’s, it is found out that: In the process of practicing that is executed with daily routines;
1) Students reacted according to the plans.
2) Students adopted the principles in CL by using the resources effectively in order to gain the skill in planning section.
3) They have performed effectively on sharing the roles.
4) More interested in topic of scenario.
5) Students focused solution of the problems as which is daily life.

This detailed explanation of application plan designed and implemented in the context of research provides practitioners to highlight how PBL can be used in CL groups. Besides, the development of best practice document by drawing upon such kind of research to construct baseline of effective applications in physics teaching. In addition to this, practitioners could have experience a PBL exercise used with their students that can be easily adapted to fit various courses.

5. Suggestions

According to results of research, the suggestions are set up in order:
1) One of the most important factor among which is effective about PBL applications is to provide the leader of education the necessity qualifications is to make teachers join collaborated learning and PBL applications which related to educational seminar.
2) In physic teaching, instead of classic lesson teaching we must create scenarios from daily life to make the subject interesting when the laws and principles are being examined about vertical movement shooting.
3) In PBL applications while collaborated groups are being created students’ interesting, skills and academic successes must be considered without making them aware. If the groups in go away.
4) In PBL applications, while consisting cooperative groups without evoking students, their interests, skills, and academic achievements should be taken into account and this help them to develop.
5) In physic teaching, providing the evaluation and generalizing the teaching materials which were prepared basically on CL and PBL, it should be the basis for other researchers to develop teaching materials concerning student based teaching methods.

References