Modeling of Motion Problems Based on Graph Theory in Maths

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***Abstract*— Among the issues related to the curriculum of math problems; the movement problems, has a significant role because it includes different kinds of problems; and different solution ways and non-routine problems can be used. It is expressed in literature examination that the students have number of difficulties in learning concepts and the relationship between them, so difficulty in teaching mathematics is usually taken. Therefore, mathematics educators agree on the issue that students should develop problem-solving skills and this should be the primary purpose of education. In this study; students instead of memorizing the solutions with formulas are suggested to use a solution model based upon graphic structure in order to understand and achieve to format their meaningful learning. In the study, made on the movement problems, firstly the problems asked about the issue are classified. Then in the generated classes 250 motion problems in different kinds are analyzed with the solution model based upon graphic structure prepared.**

Keywords*— component; Problem Solving, Forward Chaining, Backward Chaining, Graph Theory

I. Introduction

By the help of literature review, it is defined that students face several difficulties while learning the concepts and the relationships between them in mathematics education [1,2,3,4,5] and that it is usually taken difficulties in teaching mathematics [4]. Therefore, mathematics educators have a consensus on developing students' problem-solving skills and on issue that education should be prior aim.

Motion problems, among the mathematical curricula topics related problem-solving, (setting up equation problems, problem-solving strategies, translation into mathematical language, fraction problems, age problems, worker-pool problems, motion problems, percentage problems, interest problems, mixture problems) have an important place due to that they include different type questions, use of different solutions and non-routine problems.

The model, established in this study, is based on graph theory for solving of mathematical motion problems. Graph theory may be said to have its beginning in 1736 when EULER considered the (general case of the) bridges of Königsberg problem: Does there exist a walk crossing each of the seven bridges of Königsberg exactly once?

It took 200 years before the first book on graph theory was written. This was "Theorie der endlichen und unendlichen Graphen" (Teubner, Leipzig, 1936) by KÖNIG in 1936. Since then graph theory has developed into an extensive and popular branch of mathematics, which has been applied to many problems in mathematics, computer science, and other scientific and not-so-scientific areas [6].

In this study, it is searched of solutions about mathematical motion problems using backward and forward chaining methods based on graph theory. In the study, made on the movement problems, firstly the problems asked about the issue are classified. Then in the generated classes 250 movement problems in different kinds are analyzed with the solution model based upon graph theory prepared. Because the structure can solve the problem in both forward and backward chaining method; it provides different solutions of the problem, if any, to be viewed.

In the light of information given, in this study, the model which solves mathematical motion problems using backward and forward chaining methods based on graph theory is introduced.

II. Material and Method

A. *Prepared Model*

TABLE I. DISPLAYING SHAPES AND MEANINGS OF THE NODES RELATIVE TO THE USED GRAPH

Node X	If known ; ● shaped and in GREEN color
	If not known ; ● shaped and in RED color
	If parametric ; ● shaped and in YELLOW color
Node V	If known ; ◉ shaped and in GREEN color
	If not known ; ◉ shaped and in RED color
	If parametric ; ◉ shaped and in YELLOW color
Node t	If known ; ◉ shaped and in GREEN color
	If not known ; ◉ shaped and in RED color
	If parametric ; ◉ shaped and in YELLOW color
Process Node	Smaller than other nodes and in orange color ●

In this study, with the adherence to the general properties of graphs, displaying shapes and meanings of the nodes related to the structure are given in the table 1; the basic graph structure that was created is also given in the figure 1.

The basic graph structure was created using the above table 1 is as follows.

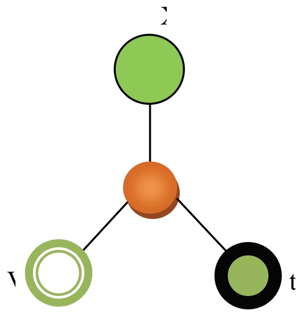

Figure 1. The basic graph structure was created

Graph structure is formed as follows in 2-vehicle cases in motion problems at the same time in opposite direction by the help of the basic graph structure.

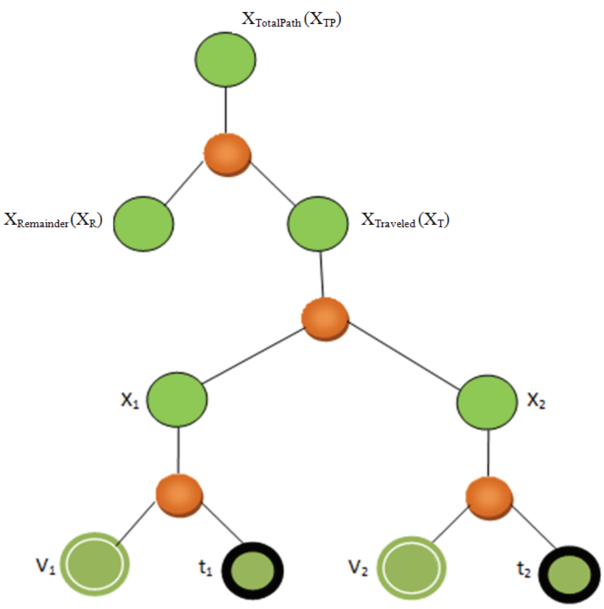

Figure 2. Graph structure that is created for 2-vehicle cases in motion problems at the same time in opposite direction.

B. A sample solution of the problem with the graph-based model solution structure

Sample Problem: Two vehicles, that there is 500 kilometers distance to each other, move towards each other at the same time with 60 km/h and 70 km/h. What is the distance between them after 3 hours? (Celal Aydın Publications Test 1/1)

For the functioning of the structure of graph in figure 2, at first given items should be defined in problem. Then, in the light of data entered, the system will solve the problem step by step by detecting nodes which should be found and unknown value. For the solution of the problem, functioning of the graph structure is shown step by step in figure 3., figure 4., and figure 5.

Given
V_1 : 60 km/h
V_2 : 70 km/h
t_1 : 3 hours
t_2 : 3 hours
X_{TP} : 500 km

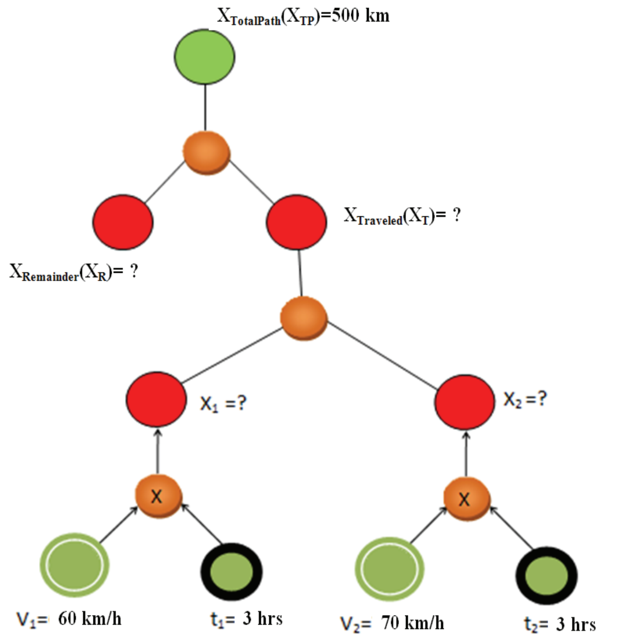

Figure 3. Graph structure relative to sample problem 1st step

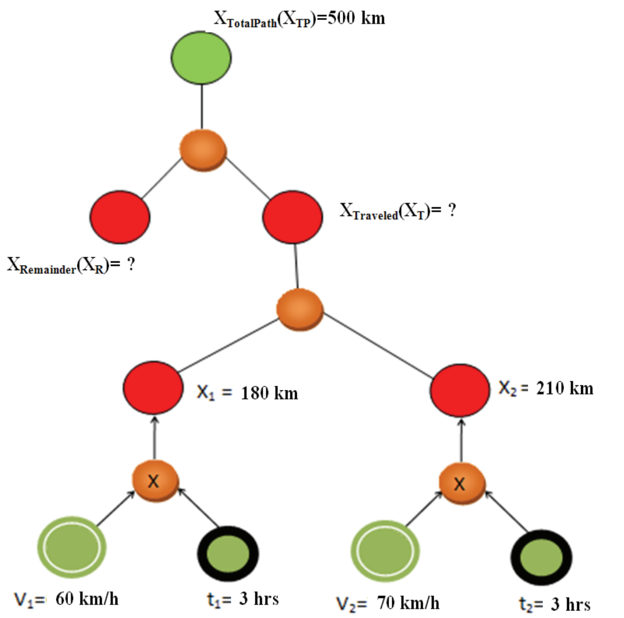

Figure 4. Graph structure relative to sample problem 2nd step

In accordance with defined rules at table 1., in the first graph created with the given, solution will primarily be tried to reach by moving with known with forward chaining. For this purpose, the system automatically will have that it should be found what routes the 1st and 2nd vehicles go.

After the calculation of the distance which 1st and 2nd vehicles go, other nodes which are empty in the graph structure will be calculated. Total path of the 2nd vehicle will be calculated in the next step. By the property of forward chaining method, remaining nodes are constantly searched and the value of all are tried to be found. After having found total path, for the calculation of the remaining path which is the last blank node, the total path traveled is subtracted from the entire path.

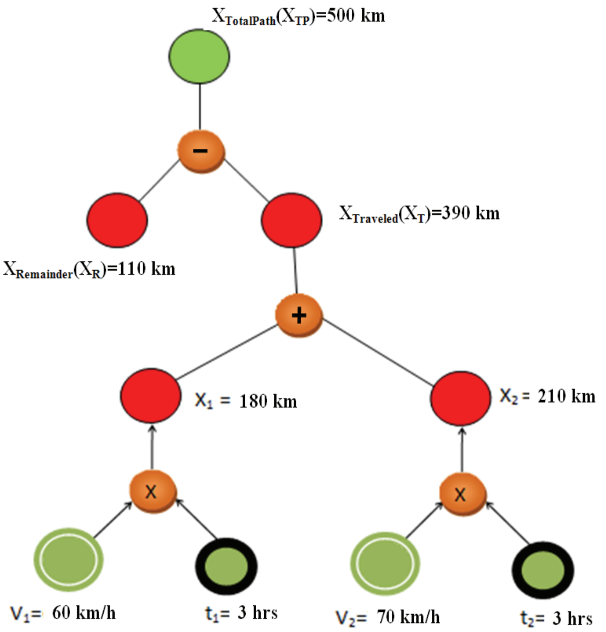

Figure 5. Graph structure relative to sample problem 3rd step

The graph structure, which its functioning is shown on a sample above, has been tested on all types of motion problems mentioned in the previous section and on about 250 problems, and it has been understood that problem can be solved with this structure. Graph structure has been started programming to make it available.

Event of back and forth move is shown on the graph in the following program part for the variable X1. Firstly, it is tried to reach result by the graph is being scanned backward. If the result cannot be accessed, graph is started to be scanned from forward.

```
private double ForX1(ref VELOCITY hz)
   {
      double x = hz. CalculateX1 (1);
         if (x <= 0)
         {
            hz.Situation.Clear();
            hz.Flag = false;
            x = hz.CalculateX1 (2);
         }
         if (x > 0)
            return x;
         return  0;
   }
```

Calculation of the value of X1 is carried out in the following part of the program. It is being calculated on graph in the form of X1 = V1 * T1 or X1 = X-X2 according to the format of the move.

```
public double CalculateX1(int kim){
          if (X1 > 0)
             return X1;
          if (kim == 2)
          {
              double v1 = CalculateV1(1);
             double t1 = CalculateT1(1);
               X1=v1 * t1;
           }
          else
          {
              double x = CalculateX(2);
             double x2=CalculateX2(2);
              X1=x-x2;
            }
       return X1;
```

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