"Routing school buses" – teacher guide

Abstract

Schools have buses for taking pupils to school in many countries. A school bus picks up pupils in the morning and drops them off at the end of the day at designated stops on the bus route. With school buses, total time on the bus is always the most important dimension (pupils have to get to school on time), and there is a known time of travel between any two bus stops. Since children must be picked up at every bus stop, a tour of all the sites (starting and ending at the school) is required.

Since the bus repeats its route every day during the school year, finding an optimal tour is crucial.

Students have to solve a problem of transport management and should make a map sketch of the particular locality, label roads and bus stops.

Discipline: Mathematics
Duration: 2 lessons (90 minutes)
Target Group: Lower Secondary School (can be adopted to Upper Secondary School)
Age range: 12-14

WoW context:

Finding the optimal route for a school bus within specific and local constraints.

Student task:

Students are given the task described below (see also the student handout). Notice the different roles the students can have. In any case, the students have to deliver a product, i.e. an optimized school bus tour map.

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Since the bus repeats its route every day during the school year, finding an optimal tour is crucial. You have to solve a problem and should make a map sketch of the particular locality, label roads and bus stops.

1. *You have to choose one of the roles:*
   - *Role of a planner (for example, school headmaster) should be taken by pupils who need a quick solution (not the best one).*
   - *Role of a mathematician fits those who would like to understand the context of the graph theory and be introduced to several algorithms.*
   - *Role of an information technology specialist also can be chosen for this task: pupils can find algorithms and software to solve some examples of this problem.*
2. *You have to present a tour map of a school bus(es), which has to take students from all the streets in the map (Fig. 1).*
3. *You have to optimize stop stations, and to estimate travelling time.*
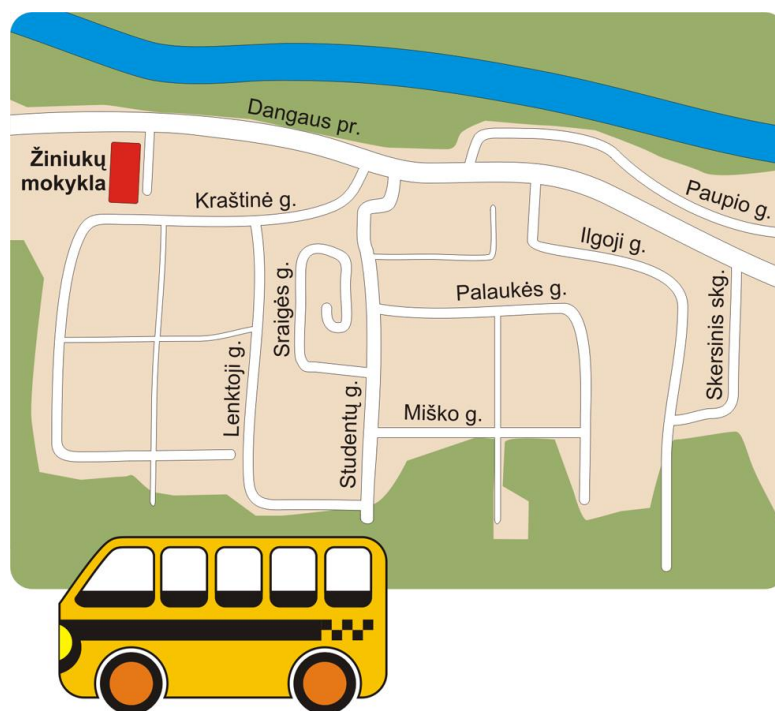4. *Be able to present and argue for your work and to discuss with other students.*

Fig. 1. The map

Equipment:

Students can use google or other online maps, preferably the local map where the school is situated.

Teaching notes:

The task belongs to the task group about graphs. Pupils could be introduced to the main graph concepts by using simple examples and drawings.
The problem is well-known to mathematicians as "Travelling salesman problem", see
http://en.wikipedia.org/wiki/Travelling_salesman_problem
https://www.youtube.com/watch?v=SC5CX8drAtU

The task formulation is clear and it seems that the solution can be found easily. However, this is one of the hardest mathematical problems. The task reflects how mathematics is used in the world of

work, where the solutions are very difficult to generate. Mathematicians need to make use of a variety of mathematical knowledge and tools to come up with a good solution.

Pupils use mathematics to make a bus route and to estimate travelling time.

Lesson plan example:

Lesson 1

10 min	Lesson can be started by discussion about the real problem, how to optimize bus travelling time to/from school. Students can be introduced by graph theory. Professions where such work is done can be discussed.
5 min	Introduce the problem. The students can ask questions about the problem. Students are grouped in groups of 3-4. The groups choose one of the presented roles and prepare to work (take computer, paper, pens etc.).
30 min	Students work on the problem. Teacher supports them as an adviser.

Lesson 2

5 min	Short repetition of the task in class. Joint answering of arising questions, discussion of unclear aspects.
20 min	Students work on the task, prepare presentations.
20 min	Each group presents their proposal.