Lesson Plan: Navigating the Chinese Postman Problem in DP Mathematics

Overview

This lesson plan is developed for International Baccalaureate (IB) Diploma Programme (DP) Mathematics students, focusing on the Chinese Postman Problem (CPP), a fundamental concept in graph theory. The lesson will cover the definition, significance, and methods for solving the CPP, with an emphasis on real-world applications like mail delivery and street cleaning. Through this lesson, students will gain insights into Eulerian paths, circuits, and graph traversal optimization.

Objectives

- Understand the Chinese Postman Problem and its application in optimizing routes.
- Explore the differences between the CPP and the Travelling Salesman Problem (TSP).
- Learn the steps for solving the CPP, focusing on Eulerian circuits and paths.
- Apply graph theory algorithms to find solutions to the CPP.

Materials

- Whiteboard and markers
- Projector for presentation and algorithm demonstrations
- Computers or tablets with graph theory software for student use
- Handouts detailing the steps for solving the CPP and examples

Lesson Duration

60 minutes

Lesson Structure

1. Introduction to the Chinese Postman Problem (10 minutes)
   - Explain the CPP and its objective: finding the shortest path to traverse each edge of a graph at least once and return to the starting point.
   - Highlight the practical significance of the CPP in urban planning, mail delivery, and other routing and scheduling tasks.

2. Distinguishing CPP from TSP (10 minutes)
   - Discuss the key differences between the CPP and the TSP, emphasizing the CPP's focus on edges rather than vertices.
   - Explain the relevance of Eulerian circuits and paths to the CPP.

3. Solving the CPP (20 minutes)
   - Walk through the algorithm for solving the CPP, including identifying odd-degree vertices, pairing odd vertices to minimize extra traversal, and creating an Eulerian circuit.
   - Use a worked example or a GeoGebra applet to visually demonstrate the solution process.

4. Hands-on Activity: Applying the CPP Algorithm (15 minutes)
   - Divide students into small groups and provide them with simple graph problems to apply the CPP algorithm manually or using graph theory software.
   - Encourage students to identify whether a given graph is Eulerian, semi-Eulerian, or non-Eulerian and to solve for the shortest postman route.

5. Discussion and Reflection (5 minutes)
   - Discuss the outcomes of the hands-on activity, focusing on the challenges encountered and strategies used to solve the CPP.
   - Reflect on the real-world implications of the CPP and the importance of graph theory in solving complex logistical problems.

Assessment

- Evaluate students' understanding through their participation in discussions and their ability to apply the CPP algorithm during the hands-on activity.
- Assess the correctness of their solutions and their explanations of the decision-making process in choosing odd vertex pairings.

Extensions

- Assign a project where students research and present on the CPP's application in a specific industry, such as waste collection or snow removal.
- Encourage students to explore advanced algorithms for solving the CPP in complex networks.

Resources

- Presentation slides with definitions, differences between CPP and TSP, and algorithm steps.
- GeoGebra applets or other graph theory software for interactive demonstrations and problem-solving.