NEA

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# Analysis

## Introducing the problem

### Background

Exeter College is a general further education college that offers a wide range of courses, there most popular of which is A levels for post 16 students. They are an award-winning college with many on site facilities located in the city centre of Exeter. Students from all across Devon enrol at Exeter College, subsequently Exeter College educates 10000+ students for any academic year.

The physics department at Exeter College is comprised of three teaches and has roughly 200 As level physics students and 150 A level physics students at any given time. Typically, a topic that has been notoriously difficult for students has been electricity.

Pino is one of the A Level physics teachers at Exeter College and wants a visually interactive tool to help make teaching the electricity topic more intuitive for her students.

In order to make the electricity topic more digestible I will be making a DC circuit simulator in the form of a website. Where the user can drag and drop different components onto lines of a grid. The website will then be able to provide feedback where the users will then be able to see the amps voltage and resistance at various points throughout the circuit. The goal is through getting the students to visually interact creating the circuits they should better understand more intuitively the different physics concepts that go along with it. For example, how amps are proportional to the resistances in different areas in parallel circuits.

### Problem

There are two main problems that the new system will attempt to solve. One, making the electricity topic for AS level physics more intuitive to understand. Two, improve the limited functionality that the current system provides.

The first problem I hope to address through the various tools and functionality of the new system. The new system will be able to perform useful calculations as well as displaying different IV characteristics for the components. The teacher will also be able to create a classroom where they can invite their students. This will be done to increase the tools usefulness within classrooms and when lesson planning. This virtual classroom will allow for the teacher to example circuits, that shows off concepts relevant to the lesson, around to the students in the classroom. Then the students will have the opportunity to play around with the circuit changing specific aspects and hopefully build the intuitive understanding through getting hands on experience seeing how the circuits responds to variations.

The second problem will again be solved by adding new tools and functionality to the new system that the old one lacks. At the moment the old system only contains a very limited number of components not all of which are obvious what components they are. Limited components means that the overall usefulness of the system is low as there is not that much that can be learned from it. My new system will not only contain more components with hopefully a more intuitive way of using the system, but also be able to perform various calculations on the circuits where appropriate such as calculating the emf of a cell or a voltage of a component.

### Research

In order to solve these problems, I have decided that the new system will most benefit from the form of a website. With a

## Users and their needs

### End users

The new system will be a website accessible by anyone and can be used without making an account. However certain features will only be accessible by those who have an account. When making an account you will need to select if you want to make a teacher or a student account. The teacher and student accounts will have the same functionality when it comes to the circuit simulator. However, the teacher account will be able to create a classroom to which they can invite students to. They will then be able to send circuits to the students for them to view and play around with. If there is time, I’d like to make a system that allows the teacher to make problems using circuits that the students will then need to solve. These problems would take the form of having limited access to a set number of components and then must arrange the components in such a way that it meets some criteria such as the voltmeter giving a specific output for example.

### Interview

Q: Would you use the current system to assist in teaching the electricity topic?

A:

Q: What features do you like about the current system or what does the current system do well?

A:

Q: What features do you not like or problems with the current system?

A:

Q: What are the most important features that you would like to see in the new system?

A:

Q: Are there any processes or calculations you would like done by the new system?

(For example, showing the iv characteristic of a filament lamp or calculating the voltage at different parts of the circuit)

A:

Q: What is the most difficult part of the electricity topic for students usually?

A:

Q: Do you have any ideas on how the new system could help the students understand these parts of the topic?

(For example, some visual way of showing current flowing or resistance increasing as current increases)

A:

Q: Are there any other comments or ideas about the new system?

A:

### User requirements

The new system should be able to provide a grid-based circuit simulator.

## SMART Objectives

1. The new system should be in the form of a website.
   1. The backend should be handled through C# and a database.
   2. The front end should be HTML, CSS and JavaScript.
2. The website should not require an account to use.
3. Website should have a sign in and sign-up page.
   1. Requires a unique username.
   2. Requires a strong password.
      1. At least 8 characters.
      2. At least one special character.
      3. At least one number.
   3. Requires an email.
      1. That email should be verified.
   4. Select whether the user a teacher or a student.
4. Once signed in the user should be able to save favourite circuits to their account to be accessed at a later date.
5. The circuit simulator should be grid based.
   1. The components of the circuit should be able to snap onto the lines of the grid.
   2. There should be a list of components in a toolbar to be used on the grid.
6. There should be minimum components for the simulator.
   1. There should be a component wire.
   2. There should be a component filament lightbulb.
   3. There should be a component cell.
   4. There should be a component battery.
   5. There should be a component voltmeter.
   6. There should be a component ammeter.
   7. There should be a component switch.
   8. There should be a component variable resistor that can be set by the user.
7. Teacher accounts should be able to create and manage multiple classrooms.
   1. Teacher accounts should be able to invite students to that classroom.
   2. Teacher accounts should be able to send example circuits to the students in the classroom.
   3. \*The teacher account should be able to create and send circuit based problems to students.\*
8. \*If there’s time advanced components to be added:\*
   1. Thermistor.
      1. The user will need to be able to change the environment of the circuit by being able to adjust the ambient temperature of the simulation.
      2. The simulator will need to be able to simulate the temperature of the circuit depending on variables such as ambient temperature, amps, voltage and resistance of the circuit.
   2. Capacitor.
   3. Diode.
   4. LED.
   5. Fuse.
   6. LDR.
      1. The user will need to be able to change the environment of the circuit by being able to adjust the ambient light of the simulation.
      2. The simulator will also need to be able to simulate the light given off by the LED or filament lightbulb.
   7. Inductor

## Modelling the problem

# Design

# Solution

# Testing

# Evaluation