Smart Rods (Hardware) Interim Report

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Project Specification

What is the problem to be solved

What are cuisinaire rods

What are their pros/cons?

How should my product improve upon them?

Define what it should do (think unit tests)

Use original spec

Background

What exists in the market

Association of teachers of mathematics magazine – use of cuisinaire rods

Design Choices

Where to put the electronics, slate or rod?

1. Rods contain a communication device and communicate with each other directly. They share their ID with each other upon contact, and this info is transmitted wirelessly to a central controller in the room, which is connected to the internet and transmits the data to the web interface.
   * **Cons:** 
     1. Power Consumption – each rod will need to be capable of transmitting and receiving wireless messages, and since they are small objects, we want to keep their batteries small, but this will draw much power
     2. Charging – each rod needs to be individually charged, and since there would be hundreds in a room, this will be impractical.
     3. Somehow, each set of rods need to be mapped to a student, and if they swap rods from different sets, they will no longer be identifiable
2. Electronic checkerboard (battery powered) is used to power and identify the rods. Each rod will have passively powered chips (something akin to RFID) and the grid will power them when the rods are placed on the checkerboard. The checkerboard will extract the id and transmit it to the controller. Could have magnetic action to help rods fit nicely on board, as children will be unlikely to place the rods perfectly
   * **Pros:**
     1. Much less power consumption, as passively powered
     2. Much fewer things to charge, and batteries can be larger on the slate
     3. Doesn’t matter if you use rods from different sets, as it is the slate that is mapped to a child

how will the slate detect a rod is on the grid?

1. By weight
   * This would be temperamental as the children will be touching the board a lot, which will make it difficult to distinguish between a child’s hand and a rod. Also it will be very difficult to distinguish between rods.
2. Magnetic fields
   * We could give each rod a different strength magnetic field and detect them using that, but that would not be reliable as the grid squares are quite small so it would be difficult to determine exact location
3. RFID Chips
   * This has a similar problem as magnetic fields, as the range of RFID is too high to be able to distinguish between the small squares on the grid. It will also be expensive to install many chips into the rods.
4. By light colour
   * We can have an RGB LED flash and measure the reflected frequencies to determine which rod is on which grid square. This is the best option because it is cheap to install LEDs, it does not suffer from location uncertainty, and it keeps the rods very simple – in fact the schools can keep the same rods they already have. Too expensive.
5. By Shorting resistors
   * Cheap and simple to implement. Very little complexity required in rods.

Implementation Plan

Rods

**Magnets**

Will need to install magnets inside plastic rods. This will give them weight and help them stick to the board

**Colours**

Need to decide what colours to use and find those inks for the 3D printer

**3D Printer**

Need to learn to use 3D printer

**Connection to board**

Different possibilities for connections w/ pros/cons

Board

**Wireless Comms**

*Security*

How much security is needed? Not sensitive info.

*Localisation*

Don’t mix transmissions with other classrooms

*Antenna*

Need to fit antenna for comms, factor this into board size.

*Controller*

Can this all be done with arduino?

*Hub*

Do we need a separate mains powered device to communicate with boards or can they communicate directly with router?

*Data Structure*

– Classroom ID

– Board ID

– Time

– Grid of positioning (calculate rod placements or just individual grid squares?)

*Protocol*

HTTP to server?

**Power**

*Battery*

Size of battery, what power management circuits need to be in place? Will Arduino draw too much power? Need mains power? Aim for ~90 Mins

*Charging interface*

Need transformer? Ask a power electronics  person.

**Rod Detection**

*Hardware*

Need arduino? How to control

Use ready made sensors? <http://bit.ly/2fSaKxD> (£0.99 **(£1.188)** eachfor 400) too expensive?

*LEDs*

Find correct size/shape

**Material**

What is the board made of – 3D print?

**Size**

Determine size of board and draw grid, allow for margins

Evaluation Plan