LITTLE BIG FUTURES

Fighting fires with the Internet of Things

COMPUTING (TEACHER NOTES)

Project overview

Time: 5 hours (including more than 3 hours of self-guided work)

Age group: 11-14 years

Challenge: Teams will design a fire-safety solution making use of connected technologies and the Internet of Things (IoT). Sub-teams will need to consider several aspects of the IoT including sensing, processing and communication across networks. They will also need to work together as a whole team to integrate the different aspects of the solution.

Learning Objectives: During the project, students will develop skills in self-management, problem solving, team work, research and communication. They will have the opportunity to draw upon knowledge from across the curriculum and outside of school.

Materials you need to run this project:

- A3 paper and coloured pens
- printed student info sheets (included)
- computer and projector for presentation (included)

Introduction

Despite many advances in fire safety, the risk to life and property from fires remains – the tragic Grenfell Tower fire is an obvious example. Around the globe there have been other notable large-scale examples in recent years, including fatal forest fires in Spain, Portugal and California; a factory fire in the Philippines; a school destroyed in Brazil; and a petrol tanker explosion in Pakistan.

In some cases the improved use of technology may help reduce harm from fire. Devices such as heat detectors and smoke alarms have saved countless lives, and are almost ubiquitous in the UK. The Internet of Things presents opportunities to make fire safety much smarter – providing better and earlier information, assisting responders in their efforts to fight fire and helping healthcare professionals to treat victims.

This Discovery CREST project involves researching problems than can be solved using connected technologies, then developing and communicating ideas for solutions. Students will draw upon their knowledge of sensors, network technologies and algorithms to make initial recommendations.

CISCO STEM LEARNING

How to run this project

This resource can be used in several ways:

- to support primary-secondary transition or for students beginning study of qualifications in computing
- for team-building on a collapsed timetable day or at the beginning of an academic year or across a sequence of lessons
- as a focus to increase engagement in STEM
- as an opportunity for collaboration between school departments (there are Little Big Futures CREST Award guides available across the STEM subjects)
- as an activity for a holiday club or youth group.

During this project, team members will be required to fulfil a variety of roles. Team members should be encouraged to try different roles, and individuals may take on more than one role.

- problem-finding, to identify existing problems that are solvable using the IoT
- research specialisms in sensing hardware, algorithms and network technology
- a technology integrationist, able to coordinate and direct the research of specialists to come to a solution that works
- a team manager who can monitor the progress of the sub-teams
- presenters who can explain the solution to others in clear terms

Lesson activities

(5 hour duration; may be extended if appropriate)

	Activity	Resources
Activity 1 (20 mins)	**Introduction** Show the newspaper headlines at the start of the presentation and use this as a stimulus for discussion. The IoT has great potential for saving lives but the legacy of the built environment presents many challenges to this becoming a reality.	PowerPoint presentation
Activity 2 (20 mins)	**Setting the Challenge** Explain that students will be working in groups to design an Internet of Things driven fire safety system that could save lives. Give each student a CREST Discovery Passport and ask them to complete the front page with their name, school and what their challenge is.	Copy of the Discovery passport document
Activity 3 (20 mins)	**Elicit existing knowledge (optional)** Thought-shower: ask students what they know about the IoT. If your students are unfamiliar with the fundamentals of the IoT it is strongly recommended that, before embarking on this project, your students work through the one-hour 'Introduction to the IoT' lesson from Little Big Futures.	

Activity 4
(20 mins)

Identify a problem

Fires can happen wherever flammable materials, oxygen (in air) and a heat source are found. Both natural and man-made environments contain many such concurrences, and humans can often be found within range of the risks. The next slides of the presentation show this 'fire triangle' and challenge teams to consider risks.

Each group might be given a unique context (slide 6) on which to focus.

In groups, students should be asked to investigate possible fire scenarios in the broadest possible sense – by doing so they will be able to generate novel solutions to interesting problems. The worldwide web, school library, broadcast and print media and other sources should be exploited, as well as the statistical sources included with this guide.

A spider-diagram is a suitable format for collecting together the thoughts of the group.

They might consider:

- possible causes
- fire detection technologies
- current fire prevention methods
- the information that is made available to people (on the scene, responders, wider public), especially through emergency channels such as alarms, lights etc
- how emergency services respond to such incidents
- risks to life and property
- unique characteristics of the fire risk
- the scale of the problem: statistics related to the scale and severity of such incidents
- barriers and opportunities related to improving fire safety

Other example locations in the built environment might include:

- residential (eg a chimney fire in a terraced house)
- commercial (eg electrical fault in a shoe shop)
- industrial (eg welding accident in a car mechanic shop)
- educational (eg arson a primary school)
- historical (eg gas lighting starting a fire in a stately home)

they might also consider:

- transportation (eg an aeroplane)
- natural environments (eg moorland)
- deliberate fires (eg terrorism or war)
- and the fact that false alarms are commonplace in many of these situations

From their research each group should agree one problem they would like to solve using the internet of things. It is important that all members of each group clearly understand the nature of this problem, as it will form the basis of the next stage of the project.

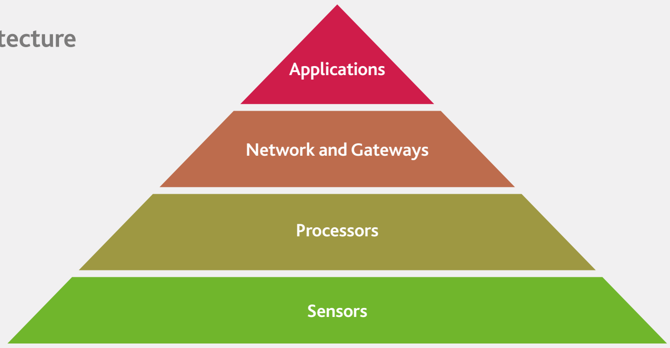
Some students may struggle with visualising an unfamiliar context, and may wish to choose an environment with which they are more familiar. You may wish to challenge other students to think beyond their immediate surroundings.

Activity 5
(90 mins)

Research elements of the IoT solution

The parts of the IoT stack up in layers, with each interfacing to those above and below. This allows the many different sensors, processing devices and network hardware components to work together – just as you can connect a computer keyboard to any PC or laptop.

A simplified diagram of IoT network architecture



Each team is aiming to produce a top-to-bottom IoT solution to their chosen fire safety problem. This can be roughly sketched on plain paper with notes added by each team member before being brought together as a recommended solution. They should be prompted to regularly revisit their problem, ensuring that they remain focused on the requirements of the solution.

Each team-member can be asked to research a layer of the IoT model and make suggestions towards a solution. This will require cooperation with team-mates as each layer must work with those above and below.

For example:

Sensors must be chosen that detect relevant and useful information related to the chosen problem.

Processing platforms must be chosen that can accept data from the chosen sensors, or that can control and power those sensors.

Network technologies must be chosen that can transmit data to the right places, from one processing device to another.

Applications must be designed to accept the data in the forms in which it arrives, and to present it in a form that is useful to the user.

Additional prompts for designing applications

Applications can be designed by approaching a problem from the user perspective. Beginning with the technology available to an identified user, either specialist or general public, these prompts can help (also on the presentation):

1. What is the human-computer interface provided by the user technology? (Touch screen, audio output, warning lights etc).
2. What is the user experience that you wish to provide?
3. What fire-related information does it provide?
4. How does this information reach the user interface?
5. How can a user application be designed to achieve your aims? What would it look like, and what would it do?
6. What benefit does the application provide to the end user over what is available today?

Security is a major consideration at all levels, and especially at the application layer where data has the most meaning and is therefore most useful to others.

Activity 6 **(90 mins)**	**Presentation (1 hour for preparation, 30 minutes for delivery of all groups)** Teams work together to produce a presentation for others in the group. It should include: ■ diagrams representing the IoT solution ■ descriptions of how each part works, and how they interact ■ the role of each team member including how they carried out their research, and how they verified the accuracy and relevance of their research	
Activity 7 **(30 mins)**	Ask each student to complete their Discovery Passport to reflect on what they have learnt, the skills they have used and how well they have worked with others.	Discovery passport document
Extension Activities	There are also many cross-curricular extensions and links that can be made, including: 1. **Science** – measurement, sensing and accuracy. Discuss the range of physical and chemical measurements that can be made, and their 'analogue' equivalents (eg thermometers, rulers). Consider the limitations of using traditional (non-electronic) measurement to inform fire safety, including how changes such as temperature rises would be monitored. 2. **Mathematics** – handling data and simple statistical methods. Methods including mean, median, mode, maximum and minimum are useful for processing data. An understanding of these would be helpful for considering the algorithms to be developed. 3. **Design and technology** – developing products to meet customer need. The ideas can be further developed by applying design thinking, resulting in product ideas that are ready for market. 4. **Computing / design and technology** – using readily-available hardware such as Raspberry Pi, groups can develop working prototypes of the whole system, or parts of it (such as a sensor-connected Arduino system that displays a data stream).	