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Teaching Guide.

Cryptography: Secrets, secrets, secrets... Everyone has them!

Introduction

The Digital Schoolhouse has teamed up with the Education Department at Bletchley Park to create a lesson that teaches pupils how to use advanced spreadsheet functionality covered at Key Stage 2 and Key Stage 3 in a fun and exciting lesson using secrets and encryption as the focus of the lesson.

Pupils will begin the lesson by looking at the history of encryption and how computing fits into the modern day communication before they develop their own encryption tool to encode and decode messages using a standard spreadsheet application. In creating these simple spreadsheets pupils will learn and use new advanced spreadsheet functions such as lookups, if statements and absolute cell referencing.

To help pupils with remembering the key vocabulary, pupils play games of Captain Jack Says (similar to Punctuation Karate) focused on the construction of formulae and key vocabulary from the lesson. Pupils will also be introduced to high frequency letters to help them decode message.

It is worth noting that the learning outcomes from this lesson can be combined with the learning from the lesson Databases: Certain Death and associated lesson resources for that lesson.

Computing Programmes of Study Links

The following elements of the KS2 Computing Programme of Study apply here:

2.2 use sequence, selection, and repetition in programs; work with variables and various forms of input and output

2.3 use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs

2.4 understand computer networks including the internet; how they can provide multiple services, such as the world wide web; and the opportunities they offer for communication and collaboration

2.6 select, use and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating and presenting data and information

2.7 use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact.

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Progression Pathway bands covered

ALG = Algorithms: Pink, Yellow, Orange, Blue

Reference

PA1	Understands what an algorithm is and is able to express simple linear (non-branching) algorithms symbolically.
PA2	Understands that computers need precise instructions.
PA3	Demonstrates care and precision to avoid errors
YA1	Understands that algorithms are implemented on digital devices as programs
YA2	Designs simple algorithms using loops, and selection i.e. if statements.
YA3	Uses logical reasoning to predict outcomes.
YA4	Detects and corrects errors i.e. debugging, in algorithms.
OA1	Designs solutions (algorithms) that use repetition and two-way selection i.e. if, then and else.
OA2	Uses diagrams to express solutions.
OA3	Uses logical reasoning to predict outputs, showing an awareness of inputs.
BA1	Shows an awareness of tasks best completed by humans or computers.
BA2	Designs solutions by decomposing a problem and creates a sub-solution for each of these parts.
BA3	Recognises that different solutions exist for the same problem.

P&D = Programming & Development: Pink, Yellow, Orange

Reference

PP1	Knows that users can develop their own programs and can demonstrate this by creating a simple program in an environment that does not rely on text
PP2	Executes, checks and changes programs
PP3	Understands that programs execute by following precise instructions
YP1	Uses arithmetic operators, if statements, and loops, within programs.
YP2	Uses logical reasoning to predict the behaviour of programs
YP3	Detects and corrects simple semantic errors i.e. debugging, in programs.

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OP1	Creates programs that implement algorithms to achieve given goals.
OP2	Declares and assigns variables.
OP3	Uses post-tested loop e.g. ‘until’, and a sequence of selection statements in programs, including an if, then and else statement.

DDR = Data & Data Representation: Pink, Yellow, Orange

Reference	
PD1	Recognises that digital content can be represented in many forms
PD2	Distinguishes between some of these forms and can explain the different ways that they communicate information
YD1	Recognises different types of data: text, number.
YD2	Appreciates that programs can work with different types of data.
YD3	Recognises that data can be structured in tables to make it useful.
OD1	Understands the difference between data and information.
OD2	Knows why sorting data in a flat file can improve searching for information.
OD3	Uses filters or can perform single criteria searches for information.
OP3	Uses post-tested loop e.g. ‘until’, and a sequence of selection statements in programs, including an if, then and else statement.

C&N = Communication & Networks: Pink, Orange, Blue

Reference	
PC1	Obtains content from the world wide web using a web browser.
PC2	Understands the importance of communicating safely and respectfully online, and the need for keeping personal information private.
PC3	Knows what to do when concerned about content or being contacted.
YC1	Navigates the web and can carry out simple web searches to collect digital content.
YC2	Demonstrates use of computers safely and responsibly, knowing a range of ways to report unacceptable content and contact when online.

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OC1	Understands the difference between the internet and internet service e.g. world wide web.
OC2	Shows an awareness of, and can use a range of internet services e.g. VOIP.
OC3	Recognises what is acceptable and unacceptable behaviour when using technologies and online services.
BC1	Understands how to effectively use search engines, and knows how search results are selected, including that search engines use 'web crawler programs'.
BC2	Selects, combines and uses internet services.
BC3	Demonstrates responsible use of technologies and online services, and knows a range of ways to report concerns.

IT = Information Technology: Pink, Yellow, Orange, Blue

Reference	
PI1	Uses software under the control of the teacher to create, store and edit digital content using appropriate file and folder names.
PI2	Understands that people interact with computers.
PI3	Shares their use of technology in school.
PI4	Knows common uses of information technology beyond the classroom
PI5	Talks about their work and makes changes to improve it.
YI1	Uses technology with increasing independence to purposefully organise digital content.
YI2	Shows an awareness for the quality of digital content collected.
YI3	Uses a variety of software to manipulate and present digital content: data and information.
YI4	Shares their experiences of technology in school and beyond the classroom.
YI5	Talks about their work and makes improvements to solutions based on feedback received.
OI1	Collects, organises and presents data and information in digital content.
OI2	Creates digital content to achieve a given goal through combining software packages and internet services to communicate with a wider audience e.g. blogging.
OI3	Makes appropriate improvements to solutions based on feedback received, and can comment on the success of the solution.

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BI1	Makes judgements about digital content when evaluating and repurposing it for a given audience.
BI2	Recognises the audience when designing and creating digital content.
BI3	Understands the potential of information technology for collaboration when computers are networked.
BI4	Uses criteria to evaluate the quality of solutions, can identify improvements making some refinements to the solution, and future solutions

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Computational Thinking Strands

AL – Algorithmic Thinking

Ref.	Activity
A1	Writing instructions that if followed in a given order (sequences) achieve a desired effect
A2	Writing instructions that use arithmetic and logical operations to achieve a desired effect
A3	Writing instructions that store, move and manipulate data to achieve a desired effect; (variables and assignment)

AB – Abstraction

Ref.	Activity
Ab1	Reducing complexity by removing unnecessary detail;
Ab2	Choosing a way to represent artefacts (whether objects, problems, processes or systems) to allow it to be manipulated in useful ways;
Ab4	Hiding complexity in data, for example by using data structures;

EV – Evaluation

Ref.	Activity
E1	Assessing that an algorithm is fit for purpose;
E2	Assessing whether an algorithm does the right thing (functional correctness);
E7	Assessment of whether a system is easy for people to use (usability);
E8	Assessment of whether a system gives an appropriately positive experience when used (user experience);
E10	Stepping through algorithms/code step by step to work out what they do (dry run / tracing);

DE – Decomposition

Ref.	Activity
D1	Breaking down artefacts (whether objects, problems, processes, solutions, systems or abstractions) into constituent parts to make them easier to work with

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Learning Outcomes

1. Be able to understand the importance of cryptography throughout history
2. Be able to understand how computers have developed over time
3. Be able to understand what is meant by the terms ‘cryptography’ and ‘encryption’
4. Have a simplistic understanding of how encryption works
5. Understand the structure of a spreadsheet, including columns, rows and cell references
6. Be able to implement simple formulae within a spreadsheet using cell references
7. Understand what is meant by the term Boolean ‘AND’ and how it is used within spreadsheets
8. Be able to implement a transposition cipher using simple spreadsheets
9. Be able to encrypt messages using simple techniques
10. Be able to decrypt messages using simple techniques
11. Be able to create and manipulate existing spreadsheets to encrypt and decrypt data
12. Be able to implement simple Lookup and IF statements to create more effective encryption techniques
13. Be able to use simple techniques to look for letter frequency patterns to help decode encrypted messages
14. Understand the importance of encryption in modern technology

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Session Overview

SESSION 1

Session Content / Activity	Resources Used	Prog. Pathway	Comp. Thinking	Computing POS Link
Welcome, Introductions General information about the day, including any Health and Safety information. Begin with some ice breaker activities	DSH_WelcomeIntroduction.ppt			
Carry out the starter activity with the class survey. Begin a discussion of student's experience/knowledge of using secret codes. Discuss the history of computing and cryptography using slides 2 – 9. Move onto a discussion of encryption and its use in today's world. All online secure sites use high levels on encryption, for example online banking has to be secure so that people feel safe carrying out their transactions using the internet.	Cryptography.ppt	C&N PC1, PC2 OC3 DDR PD1, PD2 OD1	A1 E1, E7, AB1, AB2	2.7
Describe what encryption is		C&N - PC1, PC2, OC3	AL1, E7, Ab1	2.4, 2.7
Describe the Crime Scene Detective scenario. The PowerPoint file describes a scenario based on the book "Certain Death" by Tanya Landman. Students may have read this book. The students will solve the clues throughout the day, learning the different techniques as they do so.	MMMathematics.ppt			
Give students the worksheet for clue 1 to complete. Outline the nature of the task.	Clue1.doc MMMathematics.ppt	DDR PD1, YD1, YD3	AB2, AB4, G1, D1	2.2 2.3

Working with Transposition ciphers. Work through the spreadsheet tasks outlined on the slides. Pupils work through	Cryptography.ppt TranspositionCipher-Template.xls	ALG PA1, PA2, PA3, YA1, YA3, YA4 DDR PD1, YD1, YD3 IT PI1, YI1, YI2, OI3	A1, A2, AB1, AB2, AB4, G1, D1	2.2 2.3 2.6
Explain the Substitution Cipher, what does it mean? Get pupils to open the word document and to find a way to translate the message	Substitution.doc	DDR YD1, YD3, OD1	AB1, AB2, G1, D1	2.4, 2.7

SESSION 2

Session Content / Activity	Resources Used	Prog. Pathway	Comp. Thinking	Computing POS Link
Recap the substitution cipher from Session 1. Ask students what they think it is and what it means. Work through the slides (21 – 24) to explain the code wheel. ➢ Students create the code wheel Students complete the worksheet using the code wheel that they have created	Clue 2 – Code Wheel.doc Clue 2.doc	DDR YD1, YD3, OD1	AB1, AB2, G1, D1	2.2 2.3 2.6
What would happen if we had a very long message to decode? What would the problems be? Engage the students into a brief discussion and then outline that a spreadsheet can make this task much easier for us. Work through slides 24 – 27. Pupils use the template provided	SubstitutionCipher – Template.xls	ALG PA1 – PA3, YA1 – YA4, OA1, OA3, BA1 P&D PP1 – PP3, YP1 – YP3, OP1, OP2	A1, A2, A3, AB1, AB2	2.2 2.3 2.6

Slides 28 – 30 Ask students to test their spreadsheet so far. A problem can arise if the new letter value is calculated to be greater than 26. Engage the students in discussion and ask them why this is an issue (answer: there are only 26 letters in the alphabet) Using paired/group discussion ask them to investigate a possible solution to this – write out the steps that the computer would need to solve this problem. Show slide 29 after a few moments of discussion. Once most students have attempted a solution, use class discussion techniques to help them understand and implement the answer on slide 30.	Cryptography.ppt	ALG PA1 – PA3, YA1 – YA4, OA1, OA3, BA1 P&D PP1 – PP3, YP1 – YP3, OP1, OP2 IT PI1, PI5, YI1, YI5, OI1, BI1, BI4	A1, A2, A3, AB1, AB2, E1, E2, E8, E10, G1, G2	2.2 2.3 2.6
Using the cipher wheels help students understand and implement slides 30 - 35	Cryptography.ppt			
Slides 36 – 44 Depending on time, ask student to think about what we would need to do to now decode the secret messages. Try and get students to think of the algorithms they have already implemented. Then guide them through the process of implementing the decoder	Cryptography.ppt	ALG PA1 – PA3, YA1 – YA4, OA1, OA3, BA1 P&D PP1 – PP3, YP1 – YP3, OP1, OP2 IT PI1, PI5, YI1, YI5, OI1, BI1, BI4	A1, A2, A3, AB1, AB2, E1, E2, E8, E10, G1, G2	2.2 2.3 2.6

SESSION 3

Session Content / Activity	Resources Used	Prog. Pathway	Comp. Thinking	Computing POS Link
Slides 45 – 48: looking for clues Discuss how looking at the frequency of letters can help us break the codes. Help students apply this to their own solutions.	Cryptography.ppt		Ab1, Ab2, G1, G2	
Students now need to implement what they have learnt about letter frequency. Students work to crack the code on slide 49	Clue 3.doc Clue 3 Answers.doc	ALG PA1 – PA3, YA1 – YA4, OA1, OA3, BA1	A1 – A3	2.3
Continue with the theme of the murder mystery, work through the additional clue sheets to help identify clues for the murderer. Slides 50 and 51 will be helpful here as well as the Murder Most Mathematical PowerPoint file.	Clue 4.doc Clue 4 Answers.doc Clue 5.doc Clue 5 Answers.doc Clue 6.doc Clue 6 Answers.doc Clue 7.doc MMMathematics.ppt	ALG PA1 – PA3, YA1 – YA4, OA1, OA3, BA1	A1 – A3	2.2 2.3 2.6
Ask students to put the clues aside… How does what we've learnt teach us about how things work today? After a brief discussion show the video on slide 52	http://www.youtube.com/watch?v=90cfeFBid68	C&N PC2, OC1, OC2, BC3 DDR PD1, PD2, YD1, YD3, OD1	AB1, AB2, E1, E2, E8, E10, G1, G2, D1, D2	2.4
Use the remaining resources to allow students to try and solve the mystery using	SuspectsDatabase.xls			2.3

the suspects databases. For their final suspect they complete the file and submit	Suspect_DB.doc CSI_Badge.doc

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Files/Resources

Filename	Resource Type	Purpose/Description
DSH_WelcomeIntroduction.ppt	PowerPoint	PowerPoint file to go through procedures and schedule for the day
Cryptography.ppt	PowerPoint	Main teaching resource which guides the direction of the activities
MMMathematics.ppt	PowerPoint	Teaching resource which collates the clues for the murder scenario and guides pupils directions through it
Clue 2 – Code Wheel.doc Clue 2.doc	Worksheet	Word document activity sheet for pupils to complete
SubstitutionCipher – Template.xls	Spreadsheet Template	A template for students to complete with formulae
Clue 3.doc Clue 3 Answers.doc	Worksheet	Word document activity sheet for pupils to complete
Clue 4.doc Clue 4 Answers.doc	Worksheet	Word document activity sheet for pupils to complete
Clue 5.doc Clue 5 Answers.doc	Worksheet	Word document activity sheet for pupils to complete
Clue 6.doc Clue 6 Answers.doc	Worksheet	Word document activity sheet for pupils to complete
Clue 7.doc	Worksheet	Word document activity sheet for pupils to complete
http://www.youtube.com/watch?v=90cfeFBid68	Video	World Wide Web in Plain English
SuspectsDatabase.xls	Spreadsheet	List of suspects
Suspect_DB.doc	Worksheet	Pupils complete final suspect
CSI_Badge.doc	Worksheet	Complete and print for all pupils
AnalysisCountIf.xls	Spreadsheet	Template File
MessagestoBinary-Template.xls	Spreadsheet	Template File
SubstitutionCipher-Template.xls	Spreadsheet	Template File

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TranspositionCipher-Template.xls	Spreadsheet	Template File
CaptainJackSays.xls	Spreadsheet	Template File

PLEASE NOTE: The activities outlined in this workshop pack are a suggested outline of how the workshop can be delivered. It is envisaged that teachers will adapt the resources and the organisation of them according to the needs of their class.

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