STEM Curriculum Links at Key Stages 3, 4 & 5: Florence Nightingale at Home

This document has been created in recognition of the fact that there is a lot of potential regarding the development of resources and activities relevant to student learning in STEM subjects at Secondary school. The recommendations have been split into three sections, *Mathematics*, *Science*, and *Computing & ICT*, but there are a lot of statements that are very similar between multiple subjects. Activities produced with the aim of integrating some of these links do not need to be explicitly STEM themed: they may be existing or new activities focused primarily on a GCSE History objective (for example), within which Mathematics, Science and Computing links may either already exist (and can then be made explicit) or provide opportunities to enrich or extend engagement with the subject matter. With this in mind, activities could be produced which refer to specific subject curriculum aims whilst also being truly cross-curricular.

Contents

Mathematics Curriculum Links

<table>
<tr><th>Key Stage 3</th><th>Key Stage 4</th><th>Key Stage 5</th></tr>
<tr><td colspan="3">In general, real data sets obtained from documents related to Florence Nightingale’s work and achievements (appropriately digitised) could be used as the basis for statistical study at all key stages. Where appropriate, students’ findings could be compared with Nightingale’s own, with any differences acting as discussion points. Below are examples of National Curriculum statements that could be used to inform the development of activities & resources of this kind (dependent on the specific data available):</td></tr>
<tr><th colspan="2">Working Mathematically</th><th>A / AS Level</th></tr>
<tr><td colspan="2">The below sections are general mathematical skills and practices that should be embedded throughout school teaching rather than being taught as specific topics.</td><td rowspan="3">Whilst study of Florence Nightingale’s work could be applied to many aspects of the statistical subject knowledge at Key Stage 5, an important requirement specifies that students must “become familiar with one or more specific large data</td></tr>
<tr><td colspan="2">Develop fluency</td></tr>
<tr><td>• use algebra to generalise the structure of arithmetic,</td><td>• use mathematical language and properties precisely</td></tr>
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<tr><td>including to formulate mathematical relationships</td><td></td><td rowspan="5">set(s)" which they would then explore using "technology such as spreadsheets" and "investigate questions arising in real contexts". Opportunities to work with real data are important at all Key Stages, but an appropriately digitised collection of data as used by Nightingale would be particularly valuable at A and AS level, especially if her own analysis of these data and resultant graphical representations and conclusions were provided alongside to be compared & contrasted with the students' own findings.</td></tr>
<tr><td colspan="2">Reason mathematically</td></tr>
<tr><td>• identify variables and express relations between variables algebraically and graphically
• explore what can and cannot be inferred in statistical and probabilistic settings, and begin to express their arguments formally</td><td>• extend their ability to identify variables and express relations between variables algebraically and graphically
• explore what can and cannot be inferred in statistical and probabilistic settings, and express their arguments formally
• assess the validity of an argument and the accuracy of a given way of presenting information</td></tr>
<tr><td colspan="2">Solve problems</td></tr>
<tr><td>• begin to model situations mathematically and express the results using a range of</td><td>• model situations mathematically and express the results using a range of</td></tr>
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<tr><td>formal mathematical representations</td><td>formal mathematical representations, reflecting on how their solutions may have been affected by any modelling assumptions
• select appropriate concepts, methods and techniques to apply to unfamiliar and non-routine problems; interpret their solution in the context of the given problem</td><td></td></tr>
<tr><td colspan="2">Subject content</td><td>Core Mathematics</td></tr>
<tr><td colspan="2">Statistics</td><td rowspan="2">Core Mathematics is a relatively new qualification equivalent to an A/S Level and intended for students who have not chosen to pursue Mathematics but would like to continue numerate study which will benefit future work and life skills in general.
There are currently six different Core</td></tr>
<tr><td>• describe, interpret and compare observed distributions of a single variable through: appropriate graphical representation involving discrete, continuous and grouped data; and</td><td>• infer properties of populations or distributions from a sample, whilst knowing the limitations of sampling
• interpret and construct tables and line graphs for time series data</td></tr>
</table>

appropriate measures of central tendency (mean, mode, median) and spread (range, consideration of outliers) • construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data • describe simple mathematical relationships between 2 variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs	• interpret, analyse and compare the distributions of data sets from univariate empirical distributions through: • appropriate graphical representation involving discrete, continuous and grouped data, {including box plots} • appropriate measures of central tendency (including modal class) and spread {including quartiles and inter-quartile range} • apply statistics to describe a population • use and interpret scatter graphs of bivariate data; recognise correlation and know that it does not indicate causation; draw estimated	Mathematics qualifications offered, but they all include: • Working with data • Understanding risk and probability • Understanding variation in statistics • Using exponential functions to model growth and decay • Interpreting solutions in the context of the problem • Understanding sources of error and bias when Problem-solving As the purpose of these courses is to explore functional mathematics, the same principles as for A-Level Mathematics will apply to the relevance of Florence Nightingale's statistical work: it can be used to highlight and demonstrate the role

	lines of best fit; make predictions; interpolate and extrapolate apparent trends whilst knowing the dangers of so doing.	of mathematics and mathematical processes in contexts outside of the purely mathematical.

Science Curriculum Links

Key Stage 3	Key Stage 4	Key Stage 5
Generally, Florence Nightingale's work and achievements can be used to provide real-world, historical context to scientific thinking and processes, particularly the need to analyse and present data appropriately, and the role of data visualisation in presenting results in a way which allows non-specialists to understand them. Below are National Curriculum statements which could be used to inform the development of relevant activities & resources		
Working Scientifically		
The below sections are general scientific skills and practices that should be embedded throughout school teaching rather than being taught as specific topics. Many are very closely related items in the "working mathematically" section or specific topics in the Mathematics National Curriculum.		
Develop Scientific Thinking		**Independent Thinking**
• Pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility • Understand that scientific	• the ways in which scientific methods and theories develop over time • using a variety of concepts and models to develop	• apply scientific knowledge to practical contexts

methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review	scientific explanations and understanding • appreciating the power and limitations of science and considering ethical issues which may arise • explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments • recognising the importance of peer review of results and of communication of results to a range of audiences	
Experimental Skills & Strategies		**Use and application of scientific methods and practices**

• Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience • Make predictions using scientific knowledge and understanding • Make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements • Apply sampling techniques	• using scientific theories and explanations to develop hypotheses • applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments • recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative • suggesting possible improvements and further investigations	• present data in appropriate ways • evaluate results and draw conclusions with reference to measurement uncertainties and errors • present information and data in a scientific way • use appropriate software and tools to process data, carry out research and report findings
Analysis & Evaluation		**Numeracy and the application of mathematical concepts in a practical context**
• Apply mathematical concepts	• presenting observations and	• plot and interpret graphs

and calculate results • Present observations and data using appropriate methods, including tables and graphs • Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions • Present reasoned explanations, including explaining data in relation to predictions and hypotheses • Evaluate data, showing awareness of potential sources of random and systematic error • Identify further questions arising from their results	other data using appropriate methods • translating data from one form to another • carrying out and representing mathematical and statistical analysis • representing distributions of results and making estimations of uncertainty • interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions • presenting reasoned explanations, including relating data to hypotheses • being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying	• process and analyse data using appropriate mathematical skills • consider margins of error, accuracy and precision of data

	potential sources of random and systematic error • communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations	
Vocabulary, Units, Symbols & Nomenclature		**Research and referencing**
• understand and use SI units • use and derive simple equations and carry out appropriate calculations • undertake basic data analysis including simple statistical techniques	• developing their use of scientific vocabulary and nomenclature • recognising the importance of scientific quantities and understanding how they are determined • using SI units unless inappropriate • interconverting units • using an appropriate number	• use online and offline research skills including websites, textbooks and other printed scientific sources of information

	of significant figures in calculations	
Subject Content		
The following sections list National Curriculum statements from specific taught topics that may lend themselves particularly well to aspects of Florence Nightingale's story. Any resources or activities developed to align with any of these would benefit from the inclusion of one or more of the "working scientifically" statements above.		Generally, subject content at Key Stage 5 (AS & A Level) must build upon the skills, knowledge and understanding developed at GCSE (Key Stage 4), including that listed under "working scientifically". Additionally, KS5 guidance states that courses "must include a range of contemporary and other contexts," as well as providing opportunities to use mathematical understanding and appropriate ICT to analyse and interpret data. There is an explicit requirement to "evaluate the ways in which society uses science to inform decision making"

Biology		
• the content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed • the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases • the importance of bacteria in the human digestive system • the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume • the impact of exercise, asthma and smoking on the human gas exchange system	• life processes depend on molecules whose structure is related to their function • the relationship between health and disease • communicable diseases including sexually transmitted infections in humans (including HIV/AIDs) • non-communicable diseases • bacteria, viruses and fungi as pathogens in animals and plants • body defences against pathogens and the role of the immune system against disease • reducing and preventing the spread of infectious diseases in animals and plants • the process of discovery and	• Living organisms, including plants, animals and microorganisms, interact with each other and with the non-living world.

• how organisms affect, and are affected by, their environment, including the accumulation of toxic materials	development of new medicines • the impact of lifestyle factors on the incidence of non-communicable diseases	
Chemistry		
• the concept of a pure substance • diffusion in terms of the particle model	No explicit curriculum links identified	
Physics		
No explicit curriculum links identified		

Computing & ICT Curriculum Links

Key Stage 3	Key Stage 4	Key Stage 5
The English National Curriculum for Computing does not go into large amounts of detail for Key Stages 1-4, with no explicit national curriculum at Key Stage 5, although a guidance document does exist.		
The general aims for the National Curriculum for Computing that align with aspects of Florence Nightingale at Home include ensuring that students can understand and apply data representation principles and concepts; can analyse problems in computational terms (with repeated practical experience of writing computer programs in order to solve such problems); apply information technology, including new or unfamiliar technologies, analytically to solve problems; and are responsible and creative users of information and communication technology. These links could, rather than forming the basis of brand new computing-specific activities, be integrated within existing activities (i.e. whilst adapting to online delivery or delivery in ICT-equipped locations, or providing resources that lead students and teachers to explore session & activity themes after leaving the session) and/or designing new activities & sessions with Computing themes alongside other considerations.		The guidance for A and AS Level courses in Computer Science lists three assessment objectives which concentrate on (1) demonstrating knowledge and understanding, (2) applying knowledge and understanding, and (3) designing, programming and evaluating computer systems. Elements within these three objectives that have particular relevance to Florence Nightingale's story are included below:

Subject Content		
• make appropriate use of data structures [for example, lists, tables or arrays] • undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals, including collecting and analysing data and meeting the needs of known users • create, reuse, revise and repurpose digital artefacts for a given audience, with attention to trustworthiness, design and usability	• develop their capability, creativity and knowledge in computer science, digital media and information technology • develop and apply their analytic, problem-solving, design, and computational thinking skills	• Demonstrate knowledge of the principles and concepts of […] data representation […] • Demonstrate understanding of the principles and concepts of […] data representation […] • Analyse problems in computational terms • Design computer systems that solve problems • Program computer systems that solve problems • – Evaluate computer systems that solve problems, making reasoned judgements about these and presenting conclusions