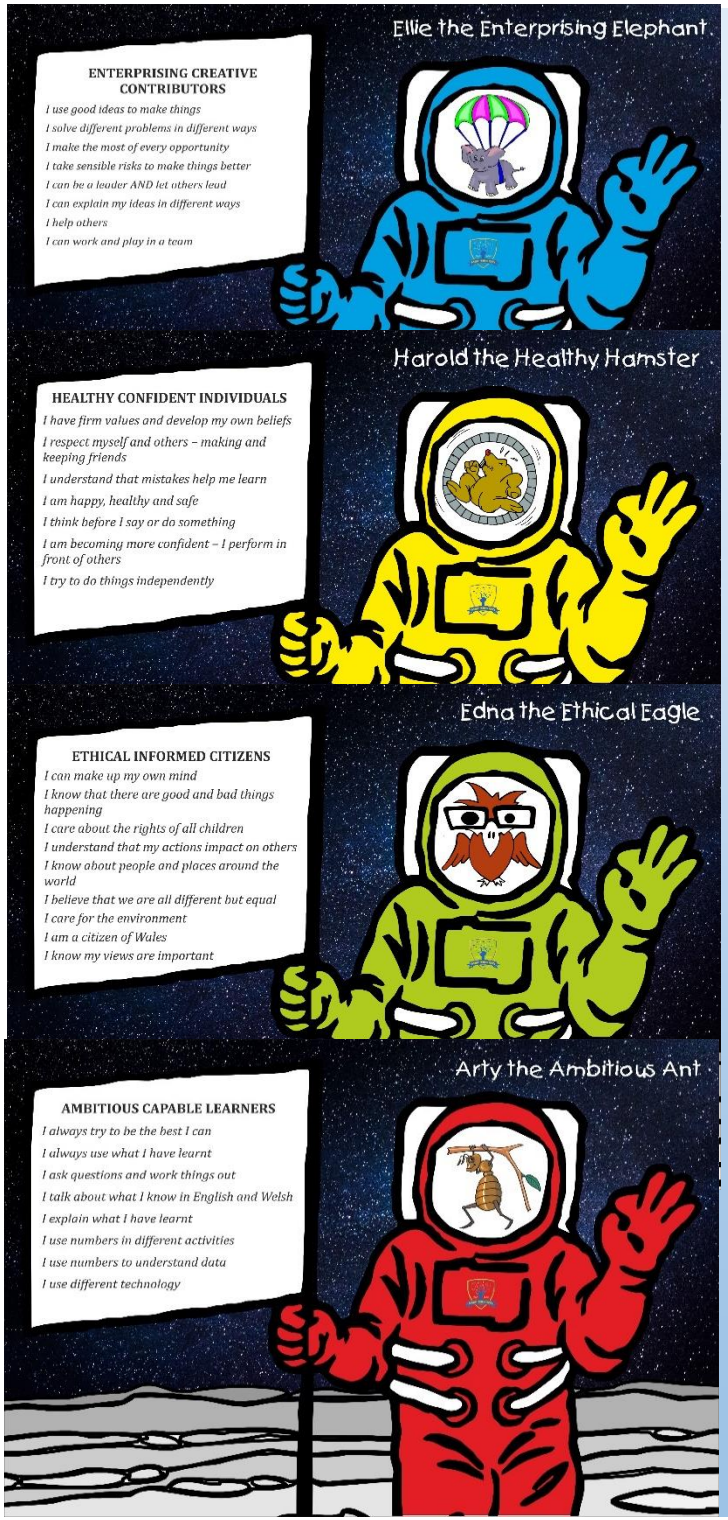

PENGELLI PRIMARY SCHOOL

REACH FOR THE STARS

CURRICULUM 2022

SCIENCE AND TECHNOLOGY

OVERVIEW

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Procedural aspects of this Area can include:

- **different types of inquiry**, including out of classroom learning, the identification and mitigation of risks and hazards and appropriate use of a range of equipment, as well as user-centred inquiry as part of the design thinking process
- **using models** (from Progression step 3) with learners building, refining, using and evaluating a range of models (including conceptual and mathematical models), which may include learning about how they have been advanced and refined through scientific and technological discovery. A wide range of models are used in the Area including: representing interdependence, understanding nutrient cycles, abstract models of electrical currents, and computational processes
- **observing living things** in their natural habitats throughout the 3 to 16 continuum, leading to more sophisticated classification and collection of data to measure and compare biodiversity
- learning **how materials can be manipulated**:
  - at earlier steps through play, mixing materials and knowing that materials can change, and under certain conditions will react to form something new, as well as be combined to create new products
  - at later steps, different types of chemical reactions can be explored including: neutralisation, oxidation, exothermic and endothermic reactions, as well as displacement and reduction
- a range of **practical techniques**, which become increasingly more complex as learning progresses (including taking measurements and making observations), as well as considering how specific techniques to separate and analyse are appropriate for different purposes, and methods of extraction
- developing conceptual and procedural **knowledge of a range of materials and techniques** through practical experiences to inform learners' design thinking and support their capacity for engineering and making
- **iterative design** processes, including continual testing and evaluating. Failure and critical feedback are important experiences and learning to respond to these helps build resilience. Using low-fidelity and high-fidelity prototyping and high-quality making also supports the iterative design process
- developing fine motor movements and gross motor movements leading to **accuracy, precision and craftsmanship** through a range of learning activities which increase in variety as learners progress
- exploring the **uses of waves** as a means of making observations and conducting tests. Experimenting with the simple refraction of light in early progression steps, for example, can build to understanding how microscopes and magnifying glasses function
- **using 'unplugged' activities throughout the 3 to 16 continuum** to help visualise computational concepts. Hands-on, practical activities with a range of tools and devices is especially relevant for teaching principles of programming and developing deeper conceptual understanding of key syntax and constructs before implementation and application
- experiences **bridging the physical and digital worlds**, through use of sensors, actuators and devices that interact with and manipulate their environment, monitoring and collecting data. When designing digital artefacts learning can be explored that focuses on human-computer interaction and user-centred design (as expressed in the design and engineering statement of what matters).

Epistemic aspects of this Area include:

- **evaluating evidence**, with learners sourcing and engaging with a range of evidence of varying validity, reliability and credibility. This includes current and past investigations, technological developments and, as learners progress, the role of data in evidence and how empirical evidence shapes ideas in science

- **the impact of science and technology** on society and the evaluation of evidence of this, including in the context of the climate emergency. Learners should have opportunities to debate the benefits and risks of technological and scientific development, building their understanding of the impact of human activity on different environments, and developing and evaluating strategies (including circular design) to minimise the negative impacts of human activity
- **investigating models** from Progression step 3. Learners should learn about different models and how they can be used to solve problems, observe trends, explain and predict behaviours
- **how components can be combined** and integrated to produce outcomes and improve functionality, including systems thinking
- **designing technology**, with deep understanding of the needs and wants of users, using empathy and investigation. Contexts can include entrepreneurial, speculative and imagining future possibilities, and should consider social, cultural, economic and environmental factors. By pursuing effective and informed design solutions, learners can acquire and apply an ever-growing body of knowledge about the world they are designing for
- **opportunities to create and innovate** through wide-ranging and unexpected sources of inspiration to find solutions. From Progression step 4 concepts such as circular design, planned obsolescence and disruptive technologies can be explored
- how knowledge of **how different materials can be applied** supports their selection for the design and manufacture of useful products
- how using a range of **digital technologies, tools and systems** across the curriculum builds understanding of how technologies can impact learners' lives and future careers.

Content aspects of this Area can include:

- the classification of **living things** and the conditions they need to survive, alongside factors which affect biological processes and the health of organisms. As learners progress processes should include respiration, photosynthesis, digestion, cell division and reproduction. This also supports learners understanding of evolution
- **understanding their own health**: how behaviours can impact learners' physical health (including nutrition, substance use and activity) as well as sexual reproduction, human development and the role of hormones
- the **nature of materials** and the different ways that substances can be classified. As learners progress this can build deep knowledge of particle theory including the composition of particles and how they interact:
  - building from exploratory learning through play, learning about physical properties of materials and states (such as solids, liquids and gases) can lead in later learning to developing knowledge about molecular structures
  - over time, understanding the properties of metals and non-metals, how properties are affected by their structures (e.g. conductivity, melting point and malleability), the nature of organic and inorganic substances, and different types of radiation
- how understanding **trends in reactivity** can be supported by learning through the periodic table in later progression steps:
  - knowledge of the relationships between elements; recognising trends and patterns and making predictions about different types of bonding
  - how rates of reactions are affected by factors (such as temperature, concentration and surface area) leading to other factors (such as using a catalyst or changing pressure)
  - undertaking calculations on the physical properties involved in reactions; masses, concentrations, volumes and energy using word and symbol equations and interpretation of chemical formulae
- **natural materials** (e.g. oil and ores) and their processing, as well as different chemical tests. Understanding of the use of the reactivity series in metal extraction, and that the majority of materials must be processed before they can be used is, for example, helpful in learning about the impact of science and technology on the environment

- knowledge of the **working properties of materials** (including finishes), as well as making, manufacturing and construction techniques (including those that learners will not be able to experience in school, but will need to have an understanding of)
- **magnetic fields** and the nature of permanent magnets, with connections that enable broader learning about motors and generators. The combination of magnetic fields and forces enables electricity to be generated and used to create motion, which builds towards an understanding of Fleming's Laws in later progression steps
- the **conversion of energy** to various useful or wasted forms through electricity generation or use. This can lead to an appreciation of the Law of Energy Conservation
- **electricity** produced by generators can lead to either direct current or alternating current. In the case of alternating current, an understanding of waves is required. For these reasons, schools can consider electricity, forces, motion, energy and magnets holistically in the design of their curriculum
- the role of **different types of waves** can enable learners to understand how we deduce the structure of the Earth, provide evidence for theories of the evolution and structure of the Universe, from digital communications in computation and contexts of diagnostic exploration using waves and data collection. Knowledge about waves can also support learners' contextual understanding of sound, acoustics and soundscapes
- **space** provides a rich source of engagement for learners, including a context for considering **energy transfer**, as well as waves and the electromagnetic spectrum to enable observations and evidence gathering. Building on knowledge of the solar system, learners can consider the motion of celestial bodies caused by the forces they experience and exert on other objects, to build an understanding of Newton's Laws of Motion
- **creating software solutions** that are fit for purpose. Knowing how to design, create, test and use software that is functional, robust and considerate of diverse audiences provides learners with the fundamental knowledge, skills and experience of how modern technologies work and can be applied
- **physical computing** focuses on the interactions between humans and our environment, using technologies that can enable us to extend, enhance and automate. Physical computing is a creative framework for better understanding human relationships to the digital world
- **communication systems**. Obtaining a deeper understanding of how the technologies that connect our world operate, their features and benefits - and the potential for misuse - can enable us to live more safely and responsibly in our interconnected world
- **storing and processing data**. Through data literacy and data management, learners can better understand how data drives our computational world. They can use a range of software tools to create, manage and interrogate datasets to investigate lines of inquiry. Using mathematical and logical operators also supports learning expressed in the Mathematics and Numeracy Area of Learning and Experience.

Illustrating breadth

The following are provided as examples of how you could explore different topical learning in this Area. These are illustrations only. Encouraging learners to evaluate scientific and technological developments in relation to the climate emergency can lead to understanding the relationships between science, personal agency, government action and economic factors here in Wales and at an international level. Evaluation of scientific and technological evidence, as well as the history of science and technology, could lead learners to discover the contributions of figures such as Frances Elizabeth Hoggan, Dorothy Hodgkin, Alan Turing and Alfred Russel Wallace. In developing coding skills, learners can also understand and evaluate how computational process have changed, and continue to change, the way we live, work and study. This can include the legal and ethical considerations around social networking, misinformation and big data.

Being curious and searching for answers is essential to understanding and predicting phenomena

Progression step 1	Progression step 2	Progression step 3
I can show curiosity and question how things work. I can explore the environment, make observations and communicate my ideas.	I can ask questions and use my experience to suggest simple methods of inquiry. I can recognise patterns from my observations and investigations and can communicate my findings. I can use my knowledge and understanding to predict effects as part of my scientific exploration. I can recognise that what I do, and the things I use, can have an impact on my environment and on living things. I can explore relationships between living things, their habitats and their life cycles. I can observe and describe ways in which materials change when they are mixed together. I can investigate different forms of energy and how it can be transferred. I can explore and communicate the basic properties of light, sound, electricity and magnetism. I can identify things in the environment which may be harmful and can act to reduce the risks to myself and others.	I can identify questions that can be investigated scientifically and suggest suitable methods of inquiry. I can suggest conclusions as a result of carrying out my inquiries. I can evaluate methods to suggest improvements.
		I can engage with scientific and technological evidence to inform my own opinions.

		I can understand how my actions and the actions of others impact on the environment and living things. I can describe the impacts of science and technology, past and present, in my everyday life.

Progression step 4
I can research, devise and use suitable methods of inquiry to investigate my scientific questions. I can use my findings to draw valid conclusions. I can evaluate and identify ways of improving the reliability of data, taking anomalies into account.
I can use a range of models to explain and make predictions.
I can select relevant scientific knowledge from a range of evidence sources to evaluate claims presented as scientific facts. I can review my own opinions based on new scientific evidence.
I can explain how the impact of our actions contribute to the changes in the environment and biodiversity. I can describe the impacts of science and technology, past and present, on society.

Design thinking and engineering offer technical and creative ways to meet society's needs and wants

Progression step 1	Progression step 2	Progression step 3
I can design while I make and communicate about what I am making. I can safely use simple tools, materials and equipment to construct and deconstruct. I can explore the properties of materials and choose different materials for a particular use. I can identify, follow and begin to create sequences and patterns in everyday activities.	I can produce designs to communicate my ideas in response to particular contexts. I can make design decisions, using my knowledge of materials and existing products, and suggest design improvements. I can explore how different component parts work together. I can safely use a range of tools, materials and equipment to construct for a variety of reasons. I have experienced using basic prototyping techniques to improve outcomes. I can identify things in the environment which may be harmful and can act to reduce the risks to myself and others. I can explore and describe the properties of materials and justify their uses.	I can draw inspiration to design from historical, cultural and other sources. I can creatively respond to the needs and wants of the user, based on the context and on the information collected.
		I can identify and consider factors when developing design proposals. I can use design thinking to test and refine my design decisions without fear of failure. I can apply my knowledge and skills when making design decisions in order to produce specific outcomes. I can consider how my design proposals will solve problems and how this may affect the environment.

		I can use design communication methods to develop and present ideas, and respond to feedback.
		I can combine component parts, materials and processes to achieve functionality and improve the effectiveness of my outcomes.
		I can select and safely use appropriate tools, materials and equipment to construct purposeful outcomes. I can use prototyping as a link between my designing and making. I can take into account the impact my making may have on the environment.

Progression step 4
I can investigate and draw inspiration from historical, cultural and other sources to design creative solutions. I can recognise and act on user needs and wants in increasingly challenging contexts.
I can identify and prioritise factors which inform my design proposals. I can develop my design thinking to test and refine my design decisions by responding to success and failure. I can develop my knowledge and skills to support and refine my design decisions in order to produce purposeful outcomes. I can adopt an iterative process to improve my design proposals, while minimising their negative impact on the environment and society.
I can use a variety of design communication methods and techniques to develop and present ideas clearly, and can respond constructively to feedback.
I can investigate, evaluate, select and combine component parts, materials or processes to improve the functionality and effectiveness of my outcomes.
I can select and safely use specialist tools and techniques in order to develop and construct my outcomes. I can use prototyping techniques to test ideas and support my making. I can use my making skills and knowledge of materials to produce high-quality and purposeful outcomes. I can evaluate and apply responsible habits of working which consider environmental and societal impacts.

The world around us is full of living things which depend on each other for survival.

Progression step 1	Progression step 2	Progression step 3
I can recognise that plants and animals are living things which grow. I can identify, follow and begin to create sequences and patterns in everyday activities.	I can recognise patterns from my observations and investigations and can communicate my findings. I can use my knowledge and understanding to predict effects as part of my scientific exploration. I can recognise that what I do, and the things I use, can have an impact on my environment and on living things. I can explore relationships between living things, their habitats and their life cycles.	I can describe how living things compete for specific resources and depend on each other for survival. I can describe the features of organisms and recognise how they allow them to live, grow and reproduce for survival in their environment.
		I can explain the role of different organs and systems that enable plants and animals to live and grow. I can describe some changes in growth and development caused by hormones.
		I can identify the threats to the development and health of organisms and recognise some natural defences, preventions and treatments.

Progression step 4
I can describe the interdependence of organisms in ecosystems and explain how this affects their chances of survival. I can explain how reproduction, mutations and the environment can lead to variation and adaptations within organisms which can affect their chances of survival.
I can describe the levels of cellular organisation and how cells perform biological processes that ensure the development and survival of organisms.
I can explain the threats to the development and health of organisms and describe how the effects of these are reduced by natural defences, preventions and treatments.

Matter and the way it behaves defines our universe and shapes our lives.

Progression step 1	Progression step 2	Progression step 3
I can explore the properties of materials and choose different materials for a particular use. I can identify, follow and begin to create sequences and patterns in everyday activities.	I can recognise patterns from my observations and investigations and can communicate my findings. I can use my knowledge and understanding to predict effects as part of my scientific exploration. I can make design decisions, using my knowledge of materials and existing products, and suggest design improvements. I can explore and describe the properties of materials and justify their uses. I can observe and describe ways in which materials change when they are mixed together.	I can recognise that changes in materials affect their properties and uses under different conditions.
		I can recognise that our planet provides natural materials and can explain why they may have been processed to make them useful.

Progression step 4
I can describe and explain the properties of different types of matter and relate these to how they are used.
I can describe different types of chemical reactions, explain their uses and identify any effects of the products formed. I can use my knowledge of chemical reactions to explain what happens when conditions are changed.
I can use different methods to analyse materials in order to understand their composition. I can describe how various materials need different techniques in order to separate and refine them.

Forces and energy provide a foundation for understanding our universe.

Progression step 1	Progression step 2	Progression step 3
I can identify, follow and begin to create sequences and patterns in everyday activities.	I can recognise patterns from my observations and investigations and can communicate my findings. I can use my knowledge and understanding to predict effects as part of my scientific exploration. I can investigate different forms of energy and how it can be transferred. I can communicate the effect forces have on myself and on objects. I can explore and communicate the basic properties of light, sound, electricity and magnetism.	I can explore how the motion of objects can be affected by applying specific forces. I can use a variety of simple models to describe the forces acting on an object.
		I can explain that energy can be transferred from one place to another and how this can be used to provide the energy we need in our modern lives.
		I can describe the factors that affect electrical circuits and this will enable me to change variables and predict what will happen.
		I can explain how the properties of sound and light will affect how they are experienced. By manipulating the properties of sound and light, I can produce a desired effect.
		I can describe how magnetic fields behave and explore a range of practical uses for them.

Progression step 4
I can explain and calculate how multiple forces acting on an object will affect its motion.
I can understand conservation of energy and can explain that energy is used at differing rates, and that this affects the power and efficiency of a system. I can apply my knowledge of energy and forces to new designs and can improve the efficiency of systems.
I can explain the factors that affect current and describe the way in which it behaves in various circuits. I can design and create circuits that will perform a desired function.
I can predict the behaviour of waves in different circumstances. By applying simple rules, I can use waves in order to learn more about the world around me.
Through experiment, I can explore magnetic fields to investigate factors that affect their strength. I can apply my understanding of the interaction of fields in order to explore uses of magnetism.

Computation is the foundation for our digital world.

Progression step 1	Progression step 2	Progression step 3
I can identify, follow and begin to create sequences and patterns in everyday activities. I am beginning to follow a sequence of instructions. I can experiment with and identify uses of a range of computing technology in the world around me.	I can safely use a range of tools, materials and equipment to construct for a variety of reasons. I can use computational thinking techniques, through unplugged or offline activities. I can create simple algorithms and am beginning to explain errors. I can follow algorithms to determine their purpose and predict outcomes. I am beginning to explain the importance of accurate and reliable data to ensure a desired outcome. I can follow instructions to build and control a physical device.	I can use conditional statements to add control and decision-making to algorithms. I can identify repeating patterns and use loops to make my algorithms more concise. I can explain and debug algorithms.
		I can use sensors and actuators in systems that gather and process data about the systems' environment. I can identify positive and negative design elements that affect user interactions.
		I can explain how digital devices can be interconnected locally and globally. I can explain the importance of securing the technology I use and protecting the integrity of my data. I can explain how my data is used by services, which can help me make more informed decisions when using technology.

		I can explain how data is stored and processed. I can effectively store and manipulate data to produce and give a visual form to useful information.

Progression step 4
I can decompose given problems and select appropriate constructs to express solutions in a variety of environments. I can select and use data structures that efficiently manage data in algorithms. I can plan and implement test strategies to identify errors in programs.
I can select and use multiple sensors and actuators that allow computer systems to interact with the world around them. I can apply design principles in order to design a range of efficient user interactions.
I can explain how systems communicate, in order to design a network. I can explain the techniques used to store and transfer data and understand their vulnerabilities.
I can choose the most appropriate format for the storage and interrogation of data. I can make use of mathematical and logical operators in different software tools to investigate a line of inquiry independently.

PROGRESSION

Increasing effectiveness as a learner - Problem-solving and design tend to be iterative; the development of skills-related resilience and self-efficacy become important to enable learning through a 'trial and improve' approach. Through this learners develop their application of skills, as well as resilience as they understand the benefit of failure in this Area to discover new ways of doing things. Over time there is an increased independence in learning, including interdependence in peer group learning. Learners should develop an awareness of their increasing sophistication of understanding and an ability to regulate their own thinking.

Increasing breadth and depth of knowledge - Progression in the Science and Technology Area is demonstrated by learners exploring and experiencing increasingly complex ideas and concepts that sit within the statements of what matters. Knowledge moves through exploration from a personal understanding of the world to an abstract view that enables learners to conceptualise and justify their understandings. Progression of learning is not linear but cyclical with learners revisiting existing knowledge, linking this with their new learning, and adjusting schema in light of new discovery.

Deepening understanding of the ideas and disciplines within areas of learning and experience - Progression in this Area includes the development of a deep understanding of the learning expressed within all the statements of what matters within the Area and the complex relationships and connections which exist between them. Investigative skills and domain specific knowledge which are developed within the context of one statement of what matters can be applied in others. Iterative approaches to problem-solving from computer science and design and technology can also be beneficial to all sciences. Early stage learning will be typified by a holistic approach to asking questions and exploring the world around the learner, with increasing specialisation at later stages.

Refinement and growing sophistication in the use and application of skills - Investigation, exploration, analysis, problem-solving, and design are key skills required as learners work along the continuum of learning in this Area. As a learner makes progress, there is increasing sophistication in the way in which they apply prior learning in this Area, explore and investigate problems, and the resulting formulation of creative solutions. There is a refinement and increasing accuracy in what learners are able to do and produce both in the physical and digital environments.

Making connections and transferring learning into new contexts - As learners progress across the continuum they will increasingly be able to make links between current learning and other experiences and knowledge developed within and beyond this Area. This will include making links with knowledge and experiences from outside the school environment. Problems within science and technology involve ethical or moral dilemmas and it is an increased understanding in the way in which these dilemmas are or even should be approached which will signify progression. Learners will develop the capacity to apply their learning in science and technology to inform their thinking and action beyond the classroom.