FARLabs 3D Imaging Simulation Curriculum Relevance

Contents

3D Imaging Simulation Experiment Details:

Experiments	Year Level Relevance	Subjects	Class Sizes
3D Imaging	9, 10, 11, 12	Physics, Chemistry, Biology	Unlimited

3D Imaging Simulation Australian Curriculum Relevance

Australian Curriculum Education Level	Curriculum Learning Outcomes and Examples

Year 9 Science Australian Curriculum	**Science Understanding: Physical Sciences**
	• Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)
	    • exploring how and why the movement of energy varies according to the medium through which it is transferred
	    • discussing the wave and particle models and how they are useful for understanding aspects of phenomena
	    • investigating the transfer of heat in terms of convection, conduction and radiation, and identifying situations in which each occurs
	
	Science as a Human Endeavour
	• Nature and development of science
	    • Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE157)
	    • Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries (ACSHE158)
	• Use and influence of science
	    • People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE160
	    • Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)
	
	Science Inquiry Skills
	• Questioning and predicting
	    • Formulate questions or hypotheses that can be investigated scientifically (ACSIS164)
	• Planning and conducting
	    • Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)
	    • Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS166)
	• Processing and analysing data and information
	    • Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS169)

	• Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)
	• Evaluating
	  • Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)
	  • Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172)
	• Communicating
	  • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

Year 10 Science
Australian Curriculum
	Science Understanding: Physical Sciences
	• Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)
	  • recognising that the Law of Conservation of Energy explains that total energy is maintained in energy transfer and transformation
	  • recognising that in energy transfer and transformation, a variety of processes can occur, so that the usable energy is reduced and the system is not 100% efficient
	  • using models to describe how energy is transferred and transformed within systems
	
	Science as a Human Endeavour
	• Nature and development of science
	  • Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE191)
	  • Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries (ACSHE192)
	• Use and influence of science
	  • People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194)
	  • Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)
	
	Science Inquiry Skills
	• Questioning and predicting
	  • Formulate questions or hypotheses that can be investigated scientifically (ACSIS198)

	• Planning and conducting
	  ◦ Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199)
	  ◦ Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS200)
	• Processing and analysing data and information
	  ◦ Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS203)
	  ◦ Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)
	• Evaluating
	  ◦ Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS205)
	  ◦ Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS206)
	• Communicating
	  ◦ Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

Senior School Science Australian Curriculum – Physics Unit 1: Thermal, nuclear and electrical physics	**Learning Outcomes**: • understand how scientific models and theories have developed and are applied to improve existing, and develop new, technologies • use science inquiry skills to design, conduct and analyse safe and effective investigations into heating processes, nuclear physics and electrical circuits, and to communicate methods and findings • use algebraic and graphical representations to calculate, analyse and predict measurable quantities associated with heating processes, nuclear reactions and electrical circuits • evaluate, with reference to empirical evidence, claims about heating processes, nuclear reactions and electrical technologies • communicate physics understanding using qualitative and quantitative representations in appropriate modes and genres.
Senior School Science Australian Curriculum – Physics Unit 2: Linear Motion and Waves	**Learning Outcomes:** • understand that waves transfer energy and that a wave model can be used to explain the behaviour of sound and light • understand how scientific models and theories have developed and are applied to improve existing, and develop new, technologies

	• use science inquiry skills to design, conduct and analyse safe and effective investigations into linear motion and wave phenomena, and to communicate methods and findings
	• use algebraic and graphical representations to calculate, analyse and predict measurable quantities associated with linear and wave motion
	• evaluate, with reference to evidence, claims about motion, sound and light-related phenomena and associated technologies
	• communicate physics understanding using qualitative and quantitative representations in appropriate modes and genres.
	
	• Mathematical Representations and relationships
	  ◦ A mechanical system resonates when it is driven at one of its natural frequencies of oscillation; energy is transferred efficiently into systems under these conditions (ACSPH073)
	  ◦ Light exhibits many wave properties; however, it cannot be modelled as a mechanical wave because it can travel through a vacuum (ACSPH074)
	  ◦ A ray model of light may be used to describe reflection, refraction and image formation from lenses and mirrors (ACSPH075)
	  ◦ A wave model explains a wide range of light-related phenomena including reflection, refraction, total internal reflection, dispersion, diffraction and interference; a transverse wave model is required to explain polarisation (ACSPH076)
	  ◦ The speed of light is finite and many orders of magnitude greater than the speed of mechanical waves (for example, sound and water waves); its intensity decreases in an inverse square relationship with distance from a point source (ACSPH077)

Senior School Science Australian Curriculum – Physics Unit 3: Gravity and electromagnetism	**Learning Outcomes:** • understand how the electromagnetic wave model explains the production and propagation of electromagnetic waves across the electromagnetic spectrum • understand transformations and transfer of energy in electromagnetic devices, as well as transformations and transfer of energy associated with motion in electric, magnetic and gravitational fields • understand how models and theories have developed over time, and the ways in which physical science knowledge and associated technologies interact with social, economic, cultural and ethical considerations • use science inquiry skills to design, conduct, analyse and evaluate investigations into uniform circular motion, projectile motion, satellite motion and gravitational and electromagnetic phenomena, and to communicate methods and findings • use algebraic and graphical representations to calculate, analyse and predict measurable quantities related to motion, gravitational effects and electromagnetic phenomena

	• evaluate, with reference to evidence, claims about motion, gravity and electromagnetic phenomena and associated technologies, and justify evaluations • communicate physics understanding using qualitative and quantitative representations in appropriate modes and genres. **Examples in context:** • Medical Imaging • Magnetic Resonance Imaging (MRI) uses the property of nuclear magnetic resonance (NMR) to magnetise nuclei inside the body and create clear and accurate images of internal structures. MRI has many advantages over other imaging techniques such as computed tomography (CT) scans and X-rays, including greater contrast between soft tissues (ACSPH086) and an ability to take images without the use of ionising radiation (ACSPH089). Due to the strong magnetic fields used in these machines, there are many safety procedures that must be followed and the procedure is often unsuitable for people with metallic implants or possible allergies to the contrast agents used (ACSPH089). **Codes:** • ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work (ACSPH086) • People can use scientific knowledge to inform the monitoring, assessment and evaluation of risk (ACSPH089) • Electromagnetic waves are transverse waves made up of mutually perpendicular, oscillating electric and magnetic fields (ACSPH112) • Oscillating charges produce electromagnetic waves of the same frequency as the oscillation; electromagnetic waves cause charges to oscillate at the frequency of the wave (ACSPH113)
Senior School Science Australian Curriculum – Physics Unit 4: Revolutions in modern physics	**Learning Outcomes:** • understand how the quantum theory of light and matter explains blackbody radiation, the photoelectric effect, and atomic emission and absorption spectra • understand how models and theories have developed over time, and the ways in which physical science knowledge and associated technologies interact with social, economic, cultural and ethical considerations • use algebraic and graphical models to solve problems and make predictions related to the theory and applications of special relativity, quantum theory and the Standard Model • communicate physics understanding using qualitative and quantitative representations in appropriate modes and genres.

	Examples in context: • Particle Accelerators • Particle accelerators propel charged particles to high speeds using a combination of electric and magnetic fields. High-energy particle accelerators are used in particle physics research to create and observe particles. These machines have gradually increased in size, complexity and in their ability to accelerate particles to higher speeds, thus increasing scientists' ability to observe new particles (ACSPH122). More practical uses of particle accelerators include their use in production of radioisotopes for medical treatments and as synchrotron light sources. The construction of the Australian Synchrotron involved collaboration between Australian and New Zealand science organisations, state and federal governments and international organisations and committees including the International Science Advisory Committee and the International Machine Advisory Committee (ACSPH127). **Codes:** • ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work (ACSPH122) • International collaboration is often required when investing in large-scale science projects or addressing issues for the Asia-Pacific region (ACSPH127)

3D Imaging Simulation Victorian Certificate of Education (VCE) Curriculum Relevance

VCE Education Level	Curriculum Learning Outcomes and Examples

VCE - Physics Unit 2: What do experiments reveal about the physical world?	**Area of Study 2 (Option 2.7): What is matter and how is it formed?**
	
	Option 2.7 (Outcome 2.7): How is radiation used to maintain human health?
	In this option students use concepts of nuclear physics to explore how the use of electromagnetic radiation and particle radiation are applied in medical diagnosis and treatment. They learn about the production and simple interpretation of images of the human body produced by a variety of imaging techniques used to observe or monitor the functioning of the human body.
	
	Key Knowledge:
	• Radiation and the human body
	    • distinguish between electromagnetic radiation and particle radiation
	    • describe how X-rays for medical use are produced including the distinction between soft and hard X-rays
	    • describe how medical radioisotopes may be produced by neutron bombardment and high energy collisions
	    • analyse decay series diagrams of medical radioisotopes with reference to type of decay and stability of isotopes
	    • compare ionising and non-ionising radiation with reference to how each affects living tissues and cells
	    • explain the effects of α, β and γ radiation on humans, including:
	        • different capacities to cause cell damage
	        • short- and long-term effects of low and high doses
	        • ionising impacts of radioactive sources outside and inside the body
	        • calculations of absorbed dose (gray), equivalent dose (sievert) and effective dose (sievert)
	• The use of radiation in diagnosis and treatment of human illness and disease
	    • compare the processes of, and images produced by, medical imaging using two or more of X-rays, computed tomography (CT), γ radiation, magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT) and positron emission tomography (PET)
	    • describe applications of medical radioisotopes in imaging and diagnosis
	    • explain the use of medical radioisotopes in therapy including the effects on healthy and damaged tissues and cells
	    • relate the detection and penetrating properties of α, β and γ radiation to their use in different medical applications
	    • analyse the strengths and limitations of a selected contemporary diagnostic or therapeutic radiation technique
	
	Key Skills:
	• Develop aims and questions, formulate hypotheses and make predictions

	• determine aims, hypotheses, questions and predictions that can be tested • identify independent, dependent and controlled variables • Plan and undertake investigations • determine appropriate type of investigation: conduct experiments; design-build-testevaluate a device; explore operation of a device; solve a scientific or technological problem; perform simulations; access secondary data, including data sourced through the internet that would otherwise be difficult to source as raw or primary data through a laboratory or a classroom • select and use equipment, materials and procedures appropriate to the investigation, taking into account potential sources of error and uncertainty • Comply with safety and ethical guidelines • apply ethical principles when undertaking and reporting investigations • apply relevant occupational health and safety guidelines while undertaking practical investigations • Conduct investigations to collect and record data • work independently and collaboratively as appropriate and within identified research constraints • systematically generate, collect, record and summarise both qualitative and quantitative data • Analyse and evaluate data, methods and scientific models • process quantitative data using appropriate mathematical relationships, units and number of significant figures • organise, present and interpret data using tables, line graphs, correlation, line of best fit, calculations of mean and fitting an appropriate curve to graphical data, including the use of error bars on graphs • take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic) • explain the merit of replicating procedures and the effects of sample sizes to obtain reliable data • evaluate investigative procedures and possible sources of bias, and suggest improvements • explain how models are used to organise and understand observed phenomena and concepts related to physics, identifying limitations of the models • Draw evidence-based conclusions • determine to what extent evidence from an investigation supports the purpose of the investigation, and make recommendations, as appropriate, for modifying or extending the investigation • draw conclusions consistent with evidence and relevant to the question under investigation • identify, describe and explain the limitations of conclusions, including identification of further evidence required • critically evaluate various types of information related to physics from journal articles, mass media and opinions presented in the public domain

	- discuss the implications of research findings and proposals
	• Communicate and explain scientific ideas
	  - use appropriate physics terminology, representations and conventions, including standard abbreviations, graphing conventions and units of measurement
	  - discuss relevant physics information, ideas, concepts, theories and models and the connections between them
	  - identify and explain formal physics terminology about investigations and concepts
	  - use clear, coherent and concise expression
	  - acknowledge sources of information and use standard scientific referencing conventions
	
	Assessment:
	• a modelling activity
	• a summary report of selected practical investigations
	• a test comprising multiple choice and/or short answer and/or extended response.
	• Practical work is a central component of learning and assessment. As a guide, between 3½ and 5 hours of class time should be devoted to student practical work and investigations in each of Areas of Study 1 and 2 and to investigations in Area of Study 3 involving the use of secondary data and/or modelling.

References

- ACARA Year 9 Science
    - https://www.australiancurriculum.edu.au/f-10-curriculum/science/?strand=Science+Understanding&strand=Science+as+a+Human+Endeavour&strand=Science+Inquiry+Skills&capability=ignore&priority=ignore&year=12009&elaborations=true
- ACARA Year 10 Science
    - https://www.australiancurriculum.edu.au/f-10-curriculum/science/?strand=Science+Understanding&strand=Science+as+a+Human+Endeavour&strand=Science+Inquiry+Skills&capability=ignore&priority=ignore&year=12010&elaborations=true
- ACARA Senior School Curriculum Physics
    - https://www.australiancurriculum.edu.au/senior-secondary-curriculum/science/physics/
- VCAA VCE Curriculum Physics
    - https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/physics/Pages/Index.aspx