**Information Communication Technologies and Science**

The purpose of this document is to assist teachers to understand how Information Communication Technologies (ICT) can be incorporated into teaching and learning programs based on Science. It includes information about:

- the four elements of ICT
- ICT across the stages of schooling.

**The four elements of ICT**

ICT offers powerful tools that can transform student learning. Students can develop and demonstrate their understanding of concepts and content in all learning areas through using ICT. It is also important that students know how to use ICT efficiently and responsibly, as well as learning how to protect themselves and secure their data. ICT has four elements:

*Creating*

The creating element involves students using ICT to create digital solutions and respond to challenges and tasks. ICT can be used to record ideas, plans and processes that clarify a task or steps; generate and manage digital solutions in response to challenges arising from learning activities; or to respond to a need or creative intention. Solutions can be created by using ICT effectively and efficiently. For more details, see Appendix 1.

*Inquiring*

Inquiring using ICT involves students investigating questions, topics or problems and experimenting and taking risks when developing new understandings. ICT can be used to investigate systems and events, measure performance of humans, objects or systems, monitor processes and perform computations. ICT can visually represent thinking, clarify thoughts, identify patterns and form relationships between new and existing knowledge. For more details, see Appendix 2.

*Communicating*

ICT can be used when students communicate in online environments to share ideas and information and to construct knowledge collaboratively. Protocols and conventions that respect collaborators and audiences must be applied. For more details, see Appendix 3.

*Protecting*

The element of protecting involves students ensuring that personal security and the rights of others are respected when using ICT. The protocols that protect personal information and recognise the intellectual property of others, and security practices that ensure safe communication and sharing of information, are particularly important. For more details, see Appendix 4.

**Across the stages of schooling**

In Science, ICT supports student learning across the three broad stages of schooling in the following ways:

*Foundation stage (Prep–Year 2)*

Students ICT skills may be developed as they learn that observations can be organised to reveal patterns, and that these patterns can be used to make predictions about phenomena. Students may use software and equipment to make observations, for example, recording frog croaks or sounds from musical instruments and noticing how these sounds can be made louder or softer, or using digital cameras to predict and record the growth of wheat seedlings under different environmental conditions.

Students may undertake information searches, for example, finding out how to look after a pet or farm animal. They may create, save and share files, for example, selecting pictures of different animals and writing simple explanations that link the animals' size and shape to how the animals move. They may use a shared folder to record and share observations, for example, local weather patterns over time.

*Breadth stage (Years 3–8)*
Students ICT skills may be developed as they explore a range of systems operating at different time and geographic scales. Students may, for example, use digital concept mapping tools to plan and research tasks, for example, constructing a machine to separate the components of mixtures and solutions. They may use software to test their own electric circuit designs prior to construction.

Students may use digital microscopes to view and record images of plant and animal cells. They may use presentation software to present the findings of a collaborative inquiry that includes text, images and video, for example, an investigation into the absorption, reflection and refraction of light. They may use computer simulations to investigate the effects on food web predator/prey relationships and population numbers due to environmental changes or introduced species, or to explore natural selection and evolution through examining Peppered Moth populations over time.

*Pathways stage (Years 9–10)*
Students ICT skills may be developed as students begin to focus on areas of particular interest related to both their future schooling and intended pathways beyond school. Students develop their understanding of how systems of personal interest at a range of scales are shaped by flows of energy and matter and interactions due to forces, and develop the ability to quantify changes and relative amounts.

Students may use computer simulations to explore radioactivity and use data logging tools and video to capture data, for example, in quantitative investigations related to Newton's laws of motion. They may use spreadsheet functions to create tables, record, sort, calculate and present data related to identify trends, for example, an investigation of energy efficiencies in the home or at school. They may combine still or moving images with other data types to represent thinking visually and to produce information files, for example, capturing or creating images to trace the cycling of matter in an ecosystem.

Students may participate in online forums and projects of interest, following appropriate protocols, by collaborating with other classes and/or schools, for example, comparison of seasonal atmospheric carbon dioxide concentrations including use of existing databases. They may use scientific poster templates to communicate findings of their own investigations.

## APPENDIX 1: CREATING WITH ICT

The element 'Creating with Information Communication Technologies (ICT)' describes the range of skills and knowledge students demonstrate when using ICT. These skills and knowledge can be grouped into four steps:

*Plan steps and processes*
Students use ICT to document the design and development process for creating their digital solutions and creative products which may or may not be digital. They annotate their plans to explain changes made during development. They reflect on processes used and note how improvements might be made for future projects.

*Generate solutions*
Students use ICT efficiently and effectively to design and manage digital solutions, single and multimodal creative products or data transformations for a range of purposes and audiences. Students understand the functions, capabilities and limitations of applications software used to create their solutions or products. They select and apply appropriate software and hardware effectively. Students apply the formats and conventions that are appropriate for the type of solution or product they create.

*Test, evaluate and refine*
Students develop criteria to test their solution or creative product during development and to evaluate the quality of their finished digital solution and make necessary changes following evaluation. They consider their intended audience/purpose and may improve their solution by receiving feedback through methods such as questionnaires, online polls, social media channels or, if appropriate, user activity.

*Implement solution*
Students implement their digital solution or creative product. As part of the creating process, students learn to communicate their solution with others, convincing them of the value of the solution and providing ways to assist others with potential subsequent changes.

Further resources to support the element `Creating with ICT' can be found on FUSE.

## APPENDIX 2: INQUIRING WITH ICT

The element 'Inquiring with Information Communication Technologies (ICT)' describes the range of skills and knowledge students demonstrate when using ICT. These skills and knowledge can be grouped into three steps:

*Investigate*
Students use ICT to capture data to support their investigations. They construct online or 'for print' questionnaires to use in surveys of peers, family and community members and use ICT to sort and analyse the data obtained to build new understandings.

Students use data capture tools such as still and video cameras, audio recorders, data loggers and sensors to measure and record changes in the environment, and measure human fitness and performance and capture moments in time.

Students use ICT spatial technologies such as GPS and GIS to capture and store geographic data that enables students to develop descriptions, explanations and conclusions about natural phenomena and the natural and built environments and human interaction with them.

*Visually represent thinking*
Using ICT, students record their decisions and actions when solving problems and clarifying thoughts. They monitor changes in their thinking and evaluate their own and others' thinking strategies. Students review these records to assess their suitability for new situations.

Students use concept maps to show connections and relationships between ideas. Tools such as mind maps, flow charts, visual maps, and timelines enable students to quickly record, structure, edit and review ideas in both linguistic and non-linguistic visual representations of their thinking.
Students construct dynamic models that demonstrate the dynamic relationships between variable and constant data to test hypotheses.

Students use spread-sheets to explore "What if…?" questions and databases to organise and analyse factual information. They search and sort databases to answer specific questions and identify relationships. They use simulations and models of system processes and interactions and ICT-controlled devices such as robots to explore hypotheses and predictions and to assist in constructing knowledge.

Students use appropriate formats and conventions to assist readability of their visual representations of their thinking.

*Undertake information searches*
Students develop complex, open-ended questions to frame and guide their investigation or inquiry. From these they identify keywords. They enter the keywords, or search string, into a search engine to conduct a broad search on their chosen topic for research and use modifiers to narrow their search to more accurately locate desired information.

Modifiers such as placing the search string in quotes (" ") will return only those information sources that exactly match the search string. This is useful when the title of a source is known. They use plus and minus modifiers to increase precision of a search. Entering the search string "Madame Curie" + "nuclear medicine" will return sources about that aspect of her life.

Students assess the credibility of each source. They assess whether it is a reliable and valid source of information. They consider things such as the type of publication, the type of domain for example .gov or

.org, the author of the publication, and the soundness and strength of the argument. Students check the accuracy of digital content by assessing whether it is well written, free from spelling mistakes and grammatically correct. They check for a bibliography and whether acceptable citations are provided.

Students evaluate the accuracy and objectivity of the information. They consider why the resource has been posted and who published it, for example whether it is from a political, personal or corporate website. They also determine whether the information is a balanced report or if the author is presenting a biased perspective. There is nothing inherently wrong with bias but it should be recognised.

Students consider any potential bias in the way their search results are displayed by the search engine. They establish an understanding of how search results are produced and sources ranked and take this into consideration when choosing sources. They distinguish between independent results and sponsored resources and are discerning in their choice.

Students justify their source choices because of the authority of the source or because the source matches the perspective the student is taking or the purpose for their writing. Students also critically engage with the content rather than just quoting the information verbatim.

Resources to support the element 'Inquiring with ICT' can be found on FUSE.

## APPENDIX 3: COMMUNICATING WITH ICT

The element 'Communicating with Information Communication Technologies (ICT)' describes the range of skills and knowledge students demonstrate when using ICT. These skills and knowledge can be grouped into two parts:

*Collaborate and share*

Students collaborate with peers and teachers real time and asynchronously through the use of online collaboration tools. They utilise a range of digital resources designed for collaboration such as collaborative workspaces, blogs, social networking sites and virtual classrooms. Through collaborating online, students work together in virtual teams or in physical teams sharing ideas that are documented digitally, motivating and encouraging each other, making decisions and accepting responsibility for different sections of a project. They also negotiate a shared meaning of the task, and blend and reconfigure existing ideas to construct new knowledge and achieve goals.

*Protocols and conventions*

Students understand appropriate etiquette when communicating digitally. When emailing, they include a clear subject line, are respectful and appropriate in their choice of language, and use suitable case. When using social media or digital collaboration tools, students use clear and succinct language to avoid being misread and utilise features such as busy or away messages to assist with communication breaks.

Students present digital data and information effectively to a wide range of audiences for a variety of purposes. Students utilise digital tools to present critical perspectives and information in interesting and thought-provoking ways. They are aware when communicating with known and unknown audiences.

Students consider the ethical, social and cultural implications when Communicating with ICT. They consider the perspectives of other users and communicate with respect. They are responsible and ethical users of ICT. Students also apply ICT protocols including acknowledging authors of digital content they use in communications. A more detailed description of the skills required for developing ethical, social and cultural understanding can be found in 'Appendix 4: Protecting with ICT'.

Further resources to support the element 'Communicating with ICT' can be found on FUSE.

## APPENDIX 4: PROTECTING WITH ICT

The element 'Protecting with Information Communication Technologies (ICT)' describes the range of skills and knowledge students demonstrate when using ICT. These skills and knowledge can be grouped into two parts:

*Safe, responsible and ethical use*

Students consider ethical, social and cultural issues when protecting with ICT. They recognise and respect the views and perspectives of other users and comply with the responsible and ethical use of ICT. Students follow or establish and implement an acceptable usage policy. They apply appropriate protocols when using ICT to safely create, communicate or share information with known and unknown audiences.

Students understand the purpose of Copyright legislation and intellectual property and understand the ways in which people can protect their work from being copied without permission. They also know the different types of Creative Commons licenses that enable users to share and reuse the content. Students discuss data collection and its use by organisations and the government, and consider the legal, ethical and social implications for the collected data.

Students identify current uses for and impacts of technology in society as well as recognising the rapidly evolving and dynamic nature of technology. They understand the ways in which technology is shaping the way society and workplaces function for example mobility, 24/7 access, global retailing and its possible implications for future use. Students understand the benefits of wearable technology including health (fitness or sleep tracking), safety (recording or fatigue monitoring) or operational (simplify logistics or increase productivity) as well as the security and privacy concerns associated with using the devices.

*Protecting and managing data and information*

Students create logical folder structures, with appropriate folder names and file names, and when creating drafts of documents, they use file names that ensure version control. Students understand the constraints to storing data and information including storage devices e.g. memory cards, optical discs, and portable hard drives, storage device capacity. They can explain the impact of file sizes on storing and transmitting files and can re-size and reformat files to reduce file size and maintain integrity of the file contents.

Students understand the reasons for backing up and archiving of data. They also understand some of the positive and negative implications of cloud based storage such as backup and recovery, storage capacity, cost, ownership and concerns with safety, copyright and privacy. Students understand digital personal security and the use of passwords to help stop others from accessing private information on a personal digital device, network, including cloud based storage and during email transmission. Students identify ways to create strong passwords and understand the reasons computer programs struggle to crack these complex combinations. They also understand the implications when passwords are disclosed such as data theft, data changes, data loss and confidentiality breaches. Students understand the importance of regularly changing their passwords to help improve security.

Students describe the variety of security implications when working in the digital world. They discover ways to prevent possible geographical, social, structural or economic vulnerabilities such as altering access rights, utilising passwords, antivirus software and firewalls, end-to-end encryption, and creating and adhering to acceptable usage policies. Students become aware of ways in which personal security could be threatened, for example, identity theft, location tracking, phishing and skimming and discuss strategies to protect their personal data and information.

Further resources to support the element 'Protecting with ICT' can be found on FUSE.