Subject design brief

Science Extension

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Queensland Government | QCAA Queensland Curriculum & Assessment Authority

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For all Queensland schools

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Introduction

A *Subject design brief* is an official written description of the senior subject for which a syllabus is developed. This clear and authoritative statement describes the *nature* and *purpose* of the senior subject for which the syllabus is developed.

Describing subjects

Foundational to contemporary curriculum literature is the acknowledgement that school subjects are not 'monolithic entities' (Goodson, 1995), but are "*loose amalgamations of segments pursuing different objectives in different manners*", "*more or less delicately held together under a common name at particular periods of history*" (Bucher & Strauss, 1961).

Further, Zongyi Deng describes a school subject as a distinctive, purpose-built, and targeted study that is constructed by selecting knowledge and skills from particular disciplines and applied fields of knowledge and by responding to different social, cultural and political demands and challenges (Deng, 2012). He states that the relationship between the school subject and disciplinary or applied fields of knowledge varies with some subjects based on, or developed from, single, multiple, or part disciplines, or reflecting an identified need in an area of study not represented in academic disciplines (Deng, 2012).

This understanding of a school subject reveals six defining characteristics which together, describe its *nature* and *purpose*.

1. The objectives that the subject is pursuing (*purpose*)
2. How the subject pursues these objectives (*nature*)
3. The set of knowledge selected from particular disciplines and applied fields of knowledge (*nature*)
4. The set of skills selected from particular disciplines and applied fields of knowledge (*nature*)
5. The social, cultural and political demands and challenges the subject is responding to (*purpose*)
6. The relationship between the subject and the disciplinary or applied fields of knowledge (*nature*).

Purpose of the subject

At the core of all scientific endeavour is the inquiry into the nature of the universe. Science uses a systematic way of thinking, involving creative and critical reasoning, in order to acquire better and more reliable knowledge. Scientists recognise that knowledge is not fixed, but is fallible and open to challenge. As such, scientific endeavour is never conducted in isolation, but builds on and challenges an existing body of knowledge in the pursuit of more reliable knowledge. This collaborative process, whereby new knowledge is gained, is essential to the cooperative advancement of science, technology, health and society in a rapidly changing world.

Sjöström (2024) argues that this view of science, that emphasises not only conceptual and procedural knowledge, should also be extended to consider the ethical, social, and personal dimensions of science. This vision for science education encourages learners to think critically about how science is used, who benefits from it, and how it can contribute to a more just, sustainable, and thoughtful society.

Science inquiry involves identifying and posing questions and working to answer them. It is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions and developing evidence-based arguments. It can easily be summarised as the 'work of a scientist' (Hackling, 2005) and is underpinned through the development of broader capabilities such as those outlined in the QCAA (2024) 21st Century Skills and the rationale for the Australian Curriculum: Science (ACARA, 2022).

The importance of preparing students for a rapidly changing world is outlined in The Alice Springs (Mparntwe) Declaration (Council of Australian Governments Education Council, 2019). The Declaration identifies two goals for the education of young Australians: the promotion of excellence and equity through the education system, and that all young Australians become confident and creative individuals, successful lifelong learners and active and informed members of the community. Science Extension aims to promote excellence by offering students the opportunity to conduct sophisticated independent inquiries, by offering a level of individualisation that is outside the typical scope of a General Science subject. By deepening students' understanding of what science is, how it is done and who it benefits, students further develop their confidence in scientific inquiry as they learn to creatively develop and conduct investigations. This provides them with the skills to enable continuous learning throughout their lives, and make them better informed citizens, especially with respect to questions accessible through science and to think critically about how science is used.

In undertaking an extension course in science, students are expected to already be introduced to one or more scientific disciplines from the suite of seven General Science subjects on offer in Queensland, specifically Agricultural Science, Biology, Chemistry, Earth and Environmental Science, Marine Science, Physics and Psychology. In these subjects, students learn and apply aspects of the knowledge and skill of the discipline (thinking, experimentation, problem-solving and research skills), understand how it works and how it may impact society. In studying these subjects, students gain appreciation for a body of scientific knowledge and the process that is undertaken to acquire this knowledge.

Students seeking to undertake a course of study in Science Extension would be expected to already possess:

- an understanding of at least one core body of discipline knowledge
- deep appreciation for aspects of the skills used by scientists to develop new knowledge
- an ability to coordinate their understandings of the knowledge and skills associated with their respective discipline/s to refine experiments, verify known scientific relationships, explain

phenomena with justification and evaluate claims by finding evidence to support or refute the claims.

With these considerations in mind, the overall educational purpose of Science Extension is to enable learners to further their:

- appreciation of the wonder of science and the significant contribution science has made to contemporary society, and its continued potential to contribute more just, sustainable and ethical futures
- understanding that diverse natural phenomena may be explained, analysed and predicted through scientific models and theories that provide a reliable basis for action
- understanding of the ways in which scientific models and theories are refined as they evolve over time, how new models and theories are developed, and how they are influenced by culture and society
- ability to critically examine how scientific knowledge is developed and used in a wide range of contexts and informs personal, local and global issues
- investigative skills, including the design and conduct of investigations to explore phenomena and solve problems, the collection and analysis of qualitative and quantitative data, and the interpretation of evidence
- ability to use accurate and precise measurement, valid and reliable evidence, and scepticism and intellectual rigour, to evaluate claims, including those encountered in public discourse, media, or community debates, with consideration of ethical and societal implications
- ability to communicate complex understanding, findings, arguments and conclusions using appropriate representations, modes and genres to a variety of audiences.

Nature of the subject

The academic discipline of Science has traditionally been seen as an overarching term to describe individual disciplines of knowledge that are both separate and interconnected.

As a core discipline of the F-10 Australian Curriculum, Science subject matter is organised under three interrelated strands, which continue into the Senior secondary Australian Curriculum and the QCAA General Science syllabuses. These strands include:

- Science understanding, where learners, among other things, select and integrate appropriate scientific knowledge to explain and predict phenomena
- Science as a human endeavour, where learners, among other things, develop understanding about the nature of science and its role in society
- Science inquiry, where learners, among other things investigate ideas, solve problems and construct evidence-based arguments.

Further to this, different approaches have been valued within the educational community when developing courses of extended scientific learning, such as

- the delineation of subject matter as ‘Standard level’ or ‘Higher level’ for individual discipline-based subjects in the International Baccalaureate (International Baccalaureate Organization, 2014a)

- research-based subjects independent of scientific discipline, such as the New South Wales Higher School Certificate Science Extension Syllabus (NSW Education Standards Authority (2022)

In the Queensland context, Science Extension seeks to honour all of these approaches to learning in Science through

- the continued appreciation for the nature of science as a means of explaining phenomena in the world we live in
- exploration of one or more disciplines of science through extended research and investigation using a common framework of scientific inquiry.

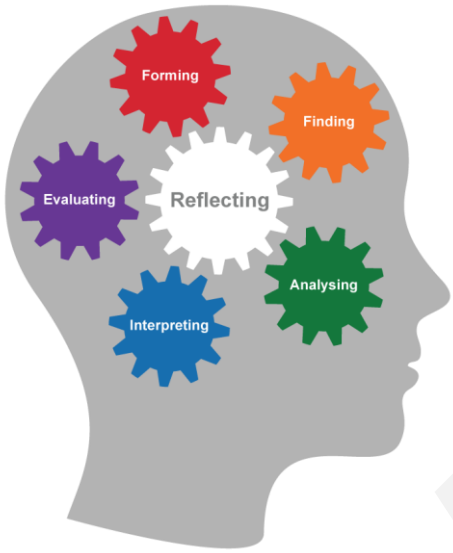
Within Science Extension, it is expected that students will engage in aspects of the work of a scientist by engaging in scientific inquiry (Tytler, 2007) that is beyond the scope of existing General Science subjects. Due to the nature of this subject in extending learners' capacity in their work as a scientist, there would be an expectation that this subject is studied after foundational knowledge has been initially developed in another science course, which continues to be studied alongside the Science Extension subject (QCAA, 2025).

These requirements provide students the necessary foundations of learning for the science inquiry skills required to do the work of a scientist. Activities related to scientific inquiry can be aided by employing a common language or framework to distinguish between stages of the process. The stages involved in any inquiry are:

- forming and describing the inquiry activity, e.g.
  - identify, research and construct questions for investigation
  - propose hypotheses and/or predict outcomes
  - design investigations suitable for the collection of valid and reliable data to respond to their question/s
- finding valid and reliable evidence for the inquiry activity, e.g.
  - use appropriate procedures to systematically collect primary
  - use credible sources to research and collect secondary data
- analysing the evidence collected, e.g.
  - use mathematical techniques to summarise data
  - select and construct appropriate representations to present data and communicate findings
  - identify trends, patterns, relationships and outliers in datasets
  - recognise error, uncertainty and limitations of evidence
- interpreting the evidence selected, e.g.
  - use graphs and other mathematical representations to determine relationships between dependent and independent variables
  - select, synthesise and use evidence to construct scientific arguments and draw arguments
- evaluating the conclusions, processes or claims, e.g.
  - use data and reasoning to discuss and evaluate the validity and reliability of evidence
  - extrapolate findings to predict future outcomes and evaluate claims
  - suggest improvements and extensions to minimise uncertainty, address limitations and improve the overall quality of evidence.

This framework uses reflection as the connection between, and driver of, all the stages (Figure 1). The progression through the inquiry process requires reflection on the decisions made and any new information that has emerged during the process to inform the next stage. Each stage of the inquiry process is worthy of reflection, the result of which may be the revision of previous stages (Marzano & Kendall, 2007).

Figure 1: Stages of inquiry process



The knowledge and skills that this extension subject seeks to develop can be organised according to four broad lines of inquiry assessing that are central to the general syllabuses, but are extended to include ethical, social, and personal dimensions of science

- the foundations of scientific thinking, which would involve the learner, among other things
  - understanding the nature of scientific thought, including its provisional and socially constructed nature, the importance of evidence and critical observation, and the questioning of assumptions and interpretations
  - appreciating the characteristics that are valued in scientific theories and hypotheses, including transparency, ethical responsibility, and contextual relevance
  - exploring scientific methods for deconstructing and defining problems and questions, including socio-political and ethical implications
- research methodologies appropriate for different contexts, which would involve the learner, among other things,
  - understanding experimental design in relation to hypothesis testing, variable types, controllable factors, sample size, replication, pseudo-replication, planning for statistical analysis, materials and methods
  - considering the ethical responsibilities involved in research design, including respect for affected communities, ecological sustainability, and social justice
- assessing suitable methods for the analysis and evaluation of data to support valid conclusions, which would involve the learner, among other things
  - exploring a range of data analysis techniques

  - conducting investigations using reliable primary and/or secondary data that may be qualitative and/or quantitative in nature
  - understanding data analysis, representation, variability, reliability
  - identifying sources of error, limitations to generalisability, and considerations for future studies, including broader ethical, social, and ecological considerations
- the quality of information presented to target audiences, which would involve the learner, among other things
  - understanding the importance of peer-reviewed research, open science, and transparency of communication in science
  - exploring how scientific ideas and issues are communicated in different genres to different audiences
  - reflecting on the responsibilities of scientists and science communicators in shaping public understanding and democratic participation in science-related issues.

A focus on these four key lines of inquiry is suitable for this two unit extension subject, providing learners with the opportunity to further their science inquiry skills and dispositions through critical engagement with real-world issues across scientific disciplines. In this respect, subject matter can be contextualised to suit the specific needs of learners as well as the discipline familiarity of the teacher.

Summary of the subject

The subject, Science Extension, would offer learning that is both meaningful and valuable. The capacity to extend students in their journey to 'work like a scientist' is key to furthering their competency in the successful collaborative advancement of science, technology, health and society in our rapidly evolving and developing world. Through engagement with this course, learners will develop increased personal agency through confidence in their capacity to explore problems through scientific inquiry.

The proposed Science Extension subject will be a companion subject to existing QCAA senior Science subjects, extending learners' knowledge and skills related to the nature and methodology of science. It will provide students with opportunities to engage in extended scientific inquiry activities not presently available in the General Science subjects, and explore topics of personal interest, including transdisciplinary topics not prescribed by existing syllabuses.

With respect to contributing to learners' literacy and numeracy, the development of extended science inquiry skills involves engagement with a broad range of data types across a variety of authentic contexts. Learners will be engaged in understanding, analysing, interpreting and evaluating new data and existing research to assess the quality of evidence presented. Learners will also be engaged in communicating research findings across multiple genres to a broad range of audiences. In addition to literacy and numeracy, the course would also support development of additional general capabilities including personal and social capability, critical and creative thinking, digital literacy and communication.

In doing so, students will develop scientific skills and mindsets, and establish a strong foundation for further study and careers in the sciences and in the broader field of STEM.

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