Practical activities in the senior Science syllabuses

List of mandatory and suggested practicals

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For all Queensland schools

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Introduction

The Queensland senior Science syllabuses describe various practical activities for students to perform. The syllabuses have two main categories of practical activities: mandatory practicals and suggested practicals. Mandatory practicals **must** be done; suggested practicals are **optional**.

Other practicals

The practical activities described in the syllabuses are **not** the only practical activities that students can perform. Many schools have specialised equipment, knowledge and expertise that provide rich and unique opportunities for students to engage in practical scientific activities beyond those described in the syllabuses. It remains the prerogative of individual schools to provide students with these learning opportunities.

Resourcing and implementation of practicals

The Science syllabuses do not specify the methodology or materials required to complete the mandatory and suggested practicals. The QCAA recognises that each Queensland school has a unique resourcing capacity. Only practicals that can be implemented effectively and flexibly using commonly available equipment have been identified in the syllabus as mandatory. Simulations, remote experiments and virtual experiments may be used where physical resources (e.g. equipment, facilities or access to appropriate sites) are limited.

Fieldwork

In syllabuses with fieldwork (i.e. Agricultural Science, Biology, Earth & Environmental Science and Marine Science), approximately five hours will be required to complete the mandatory practicals that involve fieldwork.

Practicals in the Science syllabuses

The following practicals are taken from the senior Science syllabuses (2019).

Agricultural Science

Unit	Mandatory practicals	Suggested practicals
1	• Observe, collect and record information on the physical and biological resources of a production unit including soil, climate, vegetation and topography. • Investigate and compare the digestive systems of a monogastric and a ruminant animal, using real or virtual examples. • Assess phenotypic variation in agricultural products and evaluate this data to make judgments about market suitability. • Analyse representations of both qualitative and quantitative data to make decisions about selection of breeding stock for specific breeding objectives. • Use a key to classify a range of broadacre and horticultural crops, pastures and weed species to a plant family name level. • Conduct an investigation into either respiration or photosynthesis. • Determine the appropriate fertiliser application type and rate for a given situation (e.g. crop) to use on agricultural plants (e.g. a school market garden). Collect and analyse data in response to the application type and rate (i.e. record measurements for height/yield).	• Graph secondary data for a range of industries and interpret the changes in level of production over time (e.g. years). • Simulate, construct or represent appropriate model/s for an agricultural system (contextualised using a relevant local example) showing inputs, outputs, boundaries, subsystems, processes and interactions between subsystems. • Investigate different types of animal cells or tissues, using microscopes to display cellular structures and link cell structure to the function of the tissues in the system to which they belong. • Investigate the reproductive system of an agricultural animal using real or virtual examples. • Assess reproductive soundness on a variety of livestock using qualitative and/or quantitative assessment. • Analyse primary or secondary production data to make judgments about animal reproduction. • Analyse primary or secondary production data to make judgments about genetic inheritance. • Conduct a plant survey of the school grounds and surrounds and collect a number of prominent plants. Make observations about each plant, sketch the main distinguishing features of several plants and draw conclusions about the group of plants or plant family to which they belong. • Investigate different types of plant cells and tissues using microscopes to display cellular structures and link structure to the function of the tissues in the system they belong to (e.g. transportation of water and plant nutrients to xylem and phloem). • Dissect plant structures (i.e. flowers, root system, stems and leaves). • Germinate agricultural seeds under different environmental conditions and analyse primary data to show any relationship between size of seed (energy reserves), structure of seed (e.g. dormancy) and optimum environmental conditions for germination and plant establishment. • Investigate the action of a growth hormone on plants (e.g. use various commercial hormone products on a selection of cuttings to propagate new plants).

Unit	Mandatory practicals	Suggested practicals
2	• Compare and contrast water quality from different sources and assess the impact of an agricultural activity. • Use local soil samples to measure soil properties (including organic content, pH, moisture content, soil texture and structure) to classify and assess production capacity and intended land use. • Measure climatic variables (including temperature, rainfall, humidity and wind speed) at different locations and compare the suitability of these locations for animal and/or plant production.	• Determine the soil texture and soil structure of a number of soil types and link the data to water movement, soil stability and potential for use in agricultural production systems. • Use software to compare major soil types and biological, chemical and physical characteristics of each. • Interpret data generated by technologies used to assess land capability. • Collect and interpret data to make connections between indicator plant species and land use with specific soil types (e.g. field-based or satellite imagery data). • Interpret secondary data, including ocean temperature, air pressure, rainfall and SOI, to identify El Niño and La Niña patterns.
3	• Compare the bone, muscle and fat percentages of different carcasses or cuts that are commercially available. • Design and conduct a plant trial to collect and analyse primary data on a factor that affects plant production. • Conduct an investigation into post-harvest handling of fresh plant products and its impact on product quality.	• Survey pastures or use secondary data from satellite images (including vegetation maps) to analyse results to make reasoned judgments and make decisions about quality and quantity of available food. • Formulate a ration for a selected animal. • Analyse graphs of animal developmental stages, including bone, muscle and fat proportions and summarise the information for a producer. • Analyse primary or secondary growth data to make judgments about animal nutrition. Students could analyse the growth data of animals in schools, ensuring that any work with animals is conducted in accordance with the 'Care and use of animals for scientific purposes' principles outlined in Section 1.2.4. • Analyse carcass feedback data and assess correlation with 'on-the-hoof judgments' (the practice of accurately aging an animal based on their body characteristics and proportions). • Select and perform appropriate safe handling and management techniques for the care and welfare of agricultural animals. • Monitor and record the physical aspects of the environment of a selected animal. • Analyse primary or secondary data to make judgments about the impact that plant hormones have on production. • Visit sites where different crops are being grown to discuss plant variety selection and the importance of these crops to the regional area. • Design and conduct a survey in your class, school or community for a given agricultural product to determine factors influencing demand. Analyse and evaluate the survey results to make judgments. • Identify and analyse trends in market price for an agricultural commodity over a period of time. Link fluctuations in price to variations in supply and demand.

Unit	Mandatory practicals	Suggested practicals
4	• Analyse a range of primary and/or secondary data about plant or animal production to make justified management decisions. Data sources should include at least one of the following: estimated breeding values (EBVs), live weight gain data, milk production, or grain yield from different crop varieties. • Assess the risk associated with an agricultural enterprise on a selected area in the school or on a local property using the prevention, preparedness, response, recovery (PPRR) model and make justified recommendations for improvements.	• Students can create or access a database using agricultural business software (e.g. Livestocked, PS Stockbook, Phoenix) on an electronic device to keep a record of the agricultural physical resources at the school or another appropriate local external site.

Biology

Unit	Mandatory practicals	Suggested practicals
1	• Investigate the effect of surface area to volume ratio on cell size. • Prepare wet mount slides and use a light microscope to observe cells in microorganisms, plants and animals to identify nucleus, cytoplasm, cell wall, chloroplasts and cell membrane. The student is required to calculate total magnification and field of view. • Investigate the effect of temperature on the rate of reaction of an enzyme.	• Construct a model to show the selectively permeable nature of a cell membrane (laboratory or virtual). • Use electron micrographs to identify organelles within cells. • Calculate rates of enzyme reaction, investigating inhibitors or surface areas. • Measure outputs of photosynthesis and/or respiration using plants and/or yeast as examples. • Use examples from plants and animals to explain the organisation of cells into tissues, organs and systems. • Investigate the effect of pH on the rate of reaction of an enzyme (e.g. catalase, lipase, amylase). The concentration of substrate could also be considered. • Investigate the conditions necessary for photosynthesis, e.g. compare starch present in normal, variegated and de-starched leaves. • Make wet mount slides of the leaf epidermal layer to identify, draw and label stomata, guard cells and epidermal cells and/or view pre-prepared slides; investigate differences in number of stomata in upper and lower epidermis of the leaf and between different species. • Create models to demonstrate the action of guard cells of stoma (e.g. balloon model). • View and identify prepared slides (mesophyll, xylem and phloem) in cross-sections of leaves, stems and roots. • Investigate the factors affecting the rates of transpiration using a potometer. • Use different diameter capillary tubes to demonstrate cohesion and adhesion forces in water.
2	• Compare the distribution of stomata and guard cells in plants adapted to different environments (aquatic, terrestrial) as an adaptation for osmoregulation in plant tissue. • Investigate the effect of an antimicrobial on the growth of a microbiological organism (via the measurement of zones of inhibition) — laboratory or virtual.	• Investigate tolerance limits for water or salt balance on plant growth. • Examine a virtual nerve impulse. • Investigate simple reflex arcs. • Using agar plates or another modelling activity, investigate the efficiency of hand washing compared to alcohol-based antiseptic gels for reducing bacterial load on hands.

Unit	Mandatory practicals	Suggested practicals
3	• Determine species diversity of a group of organisms based on a given index. • Use the process of stratified sampling to collect and analyse primary biotic and abiotic field data to classify an ecosystem. • Select and appraise an ecological surveying technique to analyse species diversity between two spatially variant ecosystems of the same classification (e.g. a disturbed and undisturbed dry sclerophyll forest).	• Measure abiotic factors in the classroom using field samples (e.g. pH, nitrogen nutrients, salinity, carbonates, turbidity). • Measure abiotic factors in the field (e.g. dissolved oxygen, light, temperature, wind speed, infiltration rate). • Study the abundance of each trophic level in a simple food chain. • Measure the wet biomass of producer samples. • Test the competitive exclusion principle hypothesis by studying vertical zonation on a tree. • Carry out a longitudinal study of a keystone species and relevant ecological interactions. • Conduct an abundance and distribution study, including biotic and biotic factors. • Measure the population of microorganisms in Petri dishes to observe carrying capacity.
4	• Analyse genotypic changes for a selective pressure in a gene pool (modelling can be based on laboratory work or computer simulation).	• Extract DNA from strawberries, kiwifruit or wheat germ. • Perform a bacterial transformation. • Interpret DNA profiles from gel electrophoresis (either laboratory or computer simulation based).

Chemistry

Unit	Mandatory practicals	Suggested practicals
1	• Conduct a calorimetry experiment to measure the enthalpy of a reaction. • Derive the empirical formula of a compound from reactions involving mass changes.	• Models and databases could be used to investigate periodic trends, pattern and relationships. • Simulations of Rutherford's gold foil experiment could be used. • Flame test. • Simulations could be used to examine atomic absorption spectroscopy, mass spectrometry, and absorption and emission spectra. • Separate mixtures into pure substances or simpler mixtures based on the physical properties of the substances in the mixture, including boiling point (distillation). • Test for saturation. • Apply Hess's Law. Data loggers could be used here. • Measure the molar heat of a chemical reaction. • Investigating limiting reagents.
2	• Construct 3D models (real or virtual) of linear, bent, trigonal planar, tetrahedral and pyramidal molecules. • Investigate the properties of gases to determine the molar volume of a gas. • Precipitation reactions to identify cations and anions. • Investigate the properties of strong and weak acids. • Investigate the rate of chemical reactions.	• Separate the components of a mixture using paper chromatography and/or thin layer chromatography (TLC). Simulation could be used. • Boyle's law. Simulations could be used here. • Investigate the effect of temperature on solubility. • Reactions of acids with bases, metals and carbonates.
3	• Acid-base titration to calculate the concentration of a solution with reference to a standard solution. • Perform single displacement reactions in aqueous solutions. • Construct a galvanic cell using two metal/metal-ion half cells.	• Investigate reversible reactions. • Investigate factors that affect equilibrium. Simulations could be used. • Investigate Le Châtelier's principle. • Measure pH of a substance. • Investigate the electrical conductivity of strong and weak acids and bases (simulation can be used). • Use an electrolytic cell to carry out metal plating. • Carry out electrolysis of water or copper sulfate. Simulations could be used.

Unit	Mandatory practicals	Suggested practicals
4	• Construct 3D molecules of organic molecules.	• Identify different typical functional groups in molecules. • Chemical tests to distinguish between alkanes and alkenes. • Chemical tests to distinguish primary, secondary and tertiary alcohols. • Use enzymes as catalysts. • Separate and identify components of amino acid mixtures using chromatography and or electrophoresis. Simulations could be used. Data loggers could be used. • Identify organic compounds using mass spectrometry and infrared. Simulations could be used. • Simulations of the Haber process could be used. • Simulations of contact process could be used.

Earth & Environmental Science

Unit	Mandatory practicals	Suggested practicals
1	• Identify examples of sedimentary, igneous and metamorphic rocks from the local or regional environment using key-based classification. • Use local soil samples to measure soil properties to classify and assess quality, including organic content, pH, moisture content, soil texture and structure.	• Use secondary data to interpret stratigraphic sequences and infer relative age relationships of fossils and/or sediments. • Use relevant standard measures (e.g. grain size, shape and sorting charts, felsic vs. mafic composition, and an acid test for carbonate) to collect and organise data about rock samples. • Interpret data to make connections between indicator plant species and land use with specific soil types (e.g. field-based or satellite imagery data). • Collect, organise and interpret data about the properties of water in relation to important Earth system processes. • Use standard apparatus and techniques to collect, organise and interpret data about meteorological conditions. • Collect and analyse data about the characteristics of a community by using a transect study (i.e. quadrats). If possible, a field study with an obvious plant succession would be ideal, but simulations can be used. • Model the process of the formation of different depositional environments.
2	• Identify the effect of greenhouse conditions on temperature, using a model. • Interpret the features of synoptic charts and satellite images, including high and low pressure and isobars.	• Through a laboratory experiment, investigate modes of energy transfer, including convection, conduction and radiation. • Investigate the movement of convection currents by creating a model, e.g. heating the side of a beaker of oil and measuring movement with tea leaves. • Use secondary data to compare or contrast Earth's atmosphere with sister planets Venus and Mars to appreciate the impact of greenhouse gases. • Interpret secondary data, including ocean temperature, air pressure, rainfall and SOI to identify El Niño and La Niña patterns. • Conduct an investigation into photosynthesis by testing the effect of a limiting factor (e.g. temperature, CO_2 concentration, light intensity) on the process. • Graph secondary data to compare and contrast carrying capacities in different ecosystems (e.g. a desert and tropical rainforest). • Collect local water samples and compare the levels of nitrogen and phosphorous in each sample. • Demonstrate the precipitation of carbonate minerals in solution by bubbling carbon dioxide through limewater.

Unit	Mandatory practicals	Suggested practicals
3	• Analyse and interpret geophysical and geochemical exploration datasets. • Conduct an experiment to model turbidity management strategies, using settling ponds. • Use secondary data to investigate sustainability for one of the following: – biota, including marine species and forestry – surface water and groundwater – geothermal. • Conduct an experiment to calculate and compare the efficiency of renewable energy sources (units such as kW/hr will allow direct comparison between renewable energy sources) including solar, wind and hydroelectric, evaluating their relative potential as an energy source.	• Model location, exploration and extraction of a metallic resource. Use a locality map to predict the location of a metallic resource. • Design and conduct experiments to model other separation or processing techniques (e.g. crushing, smelting and froth flotation, gravitational separation). • Investigate the effect of slope/revegetation on the volume of water run-off and amount of topsoil lost through erosion. • Model distribution and abundance surveys using quadrats or transects. An example could be a survey of weed species in a local area to determine human impact. • Investigate evaporation rates of water (surface area, volume, temperature, turbidity, salinity in lake/dam situation). • Conduct an analysis of local water samples using standard water quality testing. This could be compared to secondary data from other waterways, or historical data of the same waterway. • Students could compare and contrast the ecological footprint in different countries using secondary data.

Unit	Mandatory practicals	Suggested practicals
4	• Gather and analyse secondary data on recent and/or historic volcanic activity to evaluate the relationship between volcanic eruptions and the effect of ash clouds on global temperature patterns. • Map hazardous zones by using secondary data sources and research from valid historical records to predict possible future volcanic activity, earthquakes and tsunamis. • Model the influence of run-off coefficient of different substrates on the run-off rate in a flood event. • Analyse secondary data to evaluate the impact of changes in atmospheric carbon dioxide concentration over time to global temperatures.	• Model the design and location of buildings to mitigate against hazards, such as earthquakes and tsunamis. • Design suitable strategies to develop an action plan for sustainable development in defined hazardous areas of major weather systems, including cyclones, flood events and droughts. • Investigate historical data and case studies about major weather systems and evaluate the impacts on Earth processes and interactions. This could include: – the effects cyclones have on habitat destruction in rainforest and reef communities – the effects flood events have on erosion and river structure – the effects drought has on vegetation distribution. • Investigate examples of natural hazards (i.e. droughts, floods and bushfires) using secondary data and relevant case studies to identify the link between location and magnitude and the impact of the event. • Analyse secondary scientific data to determine how particulate materials and/or gases affect the atmosphere. • Use secondary data and climate-modelling technology to investigate the environmental impact of changes in climate over time on: – species distribution – crop productivity – sea level – rainfall patterns – surface temperature – extent of ice sheets. • Use dry ice in an alkaline solution to model acidification of oceans by CO_2. • Analyse CO_2 data from ice core data simulation models as evidence for changing atmospheric conditions over time. • Use secondary data to model patterns of El Niño and La Niña and predict future cycles and environmental implications.

Marine Science

Unit	Mandatory practicals	Suggested practicals
1	• Conduct water quality tests on a water sample.	• Conduct a convection experiment. • Investigate thermoclines (using ice and water, and hot and cold coloured water); salinity (using student-made straw hydrometers); stratification (using salt and fresh water). • Conduct a wave tank experiment. • Conduct a beach profile/dune transect and use sand sifts to decide on sphericity (roundness of sand grains).
2	• Conduct an investigation to determine factors of population dynamics (e.g. density or distribution) and assess abiotic components of a local ecosystem case study. Emphasis should be placed on assessing the processes and limitations of the chosen technique (e.g. quadrat, transect). When students identify and describe marine species, they should use field guides and identification keys.	• Estimate populations, e.g. survey count, quadrats, species density, percentage coverage, indirect or direct observation, catch and release. • Use field guides to identify to a genus level. • Use a range of field equipment to measure abiotic factors related to marine environments. • Conduct in-field mapping of food webs via gut analysis to determine food sources. • Identify physical structures of a specific marine organism (this could be virtual, practical or as a demonstration).
3	• Examine the concept of connectivity in a habitat by investigating the impact of water quality on reef health. • Investigate the effects an altered ocean pH has on marine carbonate structures.	• Identify coral genus (photo, online or field). • Classify plankton using field work techniques such as collection/trawls. • Investigate zooxanthellae (with flotsam jellyfish or aquarium coral) using a microscope. • Examine coral diversity using a transect technique (using online or field data). • Investigate how CO_2 lowers the pH of a solution. • Investigate how changes in temperature and salinity affect the solubility of CO_2 in aqueous saline solutions. • Investigate the effect of CO_2 on planktonic organisms.
4	• Apply the Lincoln index in a modelled capture–recapture scenario.	• Assess the life history of a fish by reviewing otoliths using a microscope. • Analyse a water or sand sample to identify the presence of microplastics. • Investigate factors that affect the growth rate of an aquaculture species.

Physics

Unit	Mandatory practicals	Suggested practicals
1	• Conduct an experiment that obtains data to be plotted on a scatter graph (with correct title and symbols, units and labels on the axes), analysed by calculating the equation of a linear trend line, interpreted to draw a conclusion, and reported on using scientific conventions and language. • Conduct an experiment that determines the specific heat capacity of a substance, ensuring that measurement uncertainties associated with mass and temperature are propagated. Where the mean is calculated (in this, and future experiments), determine the percentage and/or absolute uncertainty of the mean. • Conduct an experiment that measures electric current through, and electrical potential difference across an ohmic resistor in order to find resistance. – Write a research question. – Suggest modifications to the methodology used in class to improve the outcome. – Collection of sufficient data. – Consider safety and manage risks.	• Conduct an experiment to investigate the precision and accuracy of different temperature measuring devices, such as analogue and digital thermometers by determining measurement uncertainty. • Conduct an experiment to investigate the proportional relationship between heat and temperature change. • Conduct an experiment to investigate the initial and final temperature of two liquids before and after they are mixed. Compare the final temperature data with a temperature value calculated theoretically by finding the percentage error. • Conduct an experiment to observe the change in temperature while heating substances before, during and after a phase change. • Conduct an experiment or simulation investigating shielding effects and/or the relationship between intensity and distance from a radioactive source. • Conduct an experiment to compare ohmic and non-ohmic resistors. • Conduct an experiment to investigate series and parallel circuits. • Conduct an experiment to design and build simple circuits for specific ‘real-life’ purposes.

Unit	Mandatory practicals	Suggested practicals
2	• Conduct an experiment to verify the value of acceleration due to gravity on the Earth's surface. All data sets that suggest a non-linear relationship, data (e.g. t^2 versus s) should be linearised and plotted, allowing for the calculation of the equation of a linear trend line. An evaluation of the experimental process undertaken, and of the conclusions drawn, will require students to – discuss the reliability and validity of the experimental process with reference to the uncertainty and limitations of the data such as measurement uncertainty and percentage error – identify justifiable sources of imprecision and inaccuracy – suggest improvements or extensions to the experiment using the uncertainty and limitations identified. • Conduct an experiment that requires students to construct and interpret displacement–time and velocity–time graphs with resulting data. Where appropriate, students should use vertical error bars when plotting data. This ensures that they can determine the uncertainty of the gradient and intercepts using minimum and maximum lines of best fit. • Conduct an experiment to determine the refractive index of a transparent substance.	• Conduct an experiment to investigate a linear elastic collision between two objects. • Conduct an experiment to investigate the behaviour of both longitudinal waves and transverse waves on springs in relation to reflection from fixed and free ends and transmission/reflection at a medium boundary. • Conduct an experiment to investigate fundamental and harmonic wavelengths in pipes. • Conduct an experiment to calculate the speed of sound in air at a specific temperature. • Conduct an experiment to verify the law of reflection.
3	• Conduct an experiment to determine the horizontal distance travelled by an object projected at various angles from the horizontal. • Conduct an experiment to investigate the force acting on a conductor in a magnetic field. • Conduct an experiment to investigate the strength of a magnet at various distances.	• Conduct an experiment to investigate the parallel component of the weight of an object down an inclined plane at various angles. • Conduct an experiment to investigate the net forces acting on an object undergoing horizontal circular motion on a string. • Conduct an experiment (using simulations) to investigate the gravitational force between two objects by varying the mass and distance. • Conduct an experiment to investigate the relationship between orbital radius and mass for orbiting objects (simulation). • Conduct an experiment to investigate the effects of electrostatic charge on various materials, e.g. on trickling water, Coulomb meter. • Conduct an experiment to investigate the induction of an electric current using a magnet and coil. • Conduct an experiment to investigate the induced EMF from an AC generator.

Unit	Mandatory practicals	Suggested practicals
4	• Conduct an experiment (or use a simulation) to investigate the photoelectric effect. Data such as the photoelectron energy or velocity, or electrical potential difference across the anode and cathode, can be compared with the wavelength or frequency of incident light. Calculation of work functions and Planck's constant using the data would also be appropriate.	

Psychology

Unit	Mandatory practicals	Suggested practicals
1	• Use a correlational research design to conduct an investigation into the relationship between normal hours of sleep and one other variable (e.g. listening to music, food before bed, amount of exercise in the day, reading on electronic devices).	• Investigate research into the effect technology has had on the cognitive development of adolescents, and conduct a correlational study looking at the relationship between technology use and test performance. • Use an experimental methodology to conduct an investigation into divided attention and memory, replicating the 1996 investigation by Fergus Craik et al (1996).
2	• Use an experimental research design to investigate the effect of watching emotive (e.g. a scary movie) versus informative (e.g. an advertisement for toothpaste) stimuli on emotional responses (measured as changes in heart rate).	• Analyse data identifying the prevalence of psychological disorders in two different cultures.
3	• Use an experimental research design to investigate the effect of learning environment on memory, replicating aspects of the 1998 investigation by Harry Grant et al.	• Conduct an experiment to investigate the effect of expectation on perceptual set (e.g. the role of frequency in developing perceptual sets in Bugelski & Alampay 1961). • Modify an experiment investigating memory, such as – duration of short-term memory in Peterson & Peterson 1959 – the capacity of short-term memory in Miller 1956 – encoding in memory in Craik, FIM & Levy, BA 1970 – context-dependent cues on memory in Tulving & Pearlstone 1966 – levels of processing theory ▪ deep processing (semantic) in Elias & Perfetti 1973 ▪ deep and shallow processing (semantic, physical and phonemic) in Hyde & Jenkins 1973 ▪ evaluating the validity of depth of processing in Craik & Tulving 1975.
4	• Use a correlational research design to investigate the relationship between stereotypes and behaviour by replicating the 1996 investigation by John Bargh, Mark Chen and Lara Burrows (Experiment 2).	• Conduct a quasi-experimental investigation into conversational distance and one other variable.