Transdisciplinary Science
TDS315123

Course Implementation Guide

Transdisciplinary Projects
SCIENCE

Catholic Education Tasmania

independent schools tasmania

Department *for* Education, Children and Young People

Tasmanian Government

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Course Implementation Guide
Transdisciplinary Science (TDS315123)

About this document

This course implementation guide supports the course document[1]. It supports teachers to create active and engaging learning experiences.

The course document on the Office of Tasmanian Assessment, Standards and Certification's website must be used when planning, delivering and assessing this course.

The Department *for* Education, Children and Young People's A Pedagogical Framework[2] has informed this resource.

Focus area support

This is a transdisciplinary projects course.

Learners will learn about:

- applications of science that are valued in Tasmania
- how to negotiate an achievable focus of scientific inquiry
- the processes that underpin a scientific inquiry
- the science that underpins their inquiry
- the local, national and global connections of their focus
- data collection, organisation and representation
- evidence based conclusions and planning
- inquiry cycles.

Localisation and customisation

Localisation:

For providers with low numbers:

- Learners will be increasingly responsible for their inquiry and progress and any form of collaboration is assessable.

For providers in isolated areas:

- All providers should have access to replicable Tasmanian examples of scientific study wherever they are situated.

For providers delivering content remotely:

[1] A 'course document' refers to accredited course information on the TASC website.
[2] https://documentcentre.education.tas.gov.au/_layouts/15/DocIdRedir.aspx?ID=TASED-1629159896-383

- This course would need local support for learners to conduct their inquiry.

For providers delivering multiple levels in a single class:

- Implementation of this course could occur alongside *Transdisciplinary Science* Level 2.

Customisation:

Opportunities exist to customise learning and content throughout the course. For example:

- Providers should guide the broad focuses that are possible within their context, considering the resources and expertise available.
- Tasmanian applications of science and learners engaging with them is central to this course.
- Choosing a range of modes and methods to gather evidence of understanding for depth of engagement and replication of scientific practice.
- As they progress learners will differentiate their own work through self and peer assessment and discussion.
- Extended scientific inquiry and the associated evidence of learning are ideally suited to delivery and management online.

Course delivery advice

Module	Indicative Times
Module 1: Research, trial and plan • Research and trial (30 hours – weighted towards the beginning of the module) • Planning (20 hours – weighted towards the beginning of the module)	50 hours
Module 2: Conduct, monitor and refine • Researching, refining and finalising context (10 hours – throughout module) • Researching and refining scientific knowledge and methodologies (10 hours – throughout module) • Conducting and refining inquiry design and finalising the inquiry question (30 hours – throughout module)	50 hours
Module 3: Review, represent and recommend • Finalise collection of evidence from Module 2 (first 20 hours) • Analysis and presentation of inquiry (final 30 hours)	50 hours

Teaching and learning

Module 1: Research, trial and plan

The following learning outcomes are a focus of this module:

1. collaborate with others and monitor, critically analyse and manage their own learning within a scientific inquiry
2. design and conduct ethical and safe collection and analysis of data within a specific application of science to inquire into a system
3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability
5. apply the context of their inquiry locally, nationally and globally and explore relationships between technology, science and the broader community for a particular scientific application
6. analyse information they have researched to implement and adapt processes and trial methodologies while inquiring into a system

Module 1: Teaching strategies

In this course, where responsibility for learning is gradually released, teachers will need to be explicit. Learners will need to have clear parameters of what scientific focuses can be investigated and the resources available. This will enable all learners to understand the intention and goals of all tasks they complete. This will also prepare them for the inquiry they will be responsible for in the rest of the course.

Learners must complete the Inquiry Project Approval Procedures to set road-markers for learning. This will support them to assess their and their peers' progress. TASC requires this form to be collected and filed for three years by teachers. The structure of the logbook should support learners to record and organise their knowledge, skills and reflections, allowing them to track their progress in a way that is accessible. The first point where the learners will have to access their own work in-depth will be the research and plan work requirement at the end of the module.

The use of a digital logbook to aid in continual self, peer and teacher assessment is recommended. In addition, a digital logbook provides a flexible means for learners to document and access what they have found. Learners will need significant guidance throughout this module on how to develop and use the logbook. This should include regular structured time to complete and reflect on their progress, including self and peer assessment.

While the learners are exploring the Tasmanian context and possible focuses for their inquiry it is appropriate to begin with a structured common inquiry. This will help with understanding of inquiry processes and offers opportunities for teaching the required skills and habits.

Module 1: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections.

- Learners spend time exploring observable phenomena on a field trip. Once they have made their observations ask them to brainstorm explaining what can be measured about what they have observed. Use their ideas to illustrate the transdisciplinary nature of science.
- Share with learners some applications of science in Tasmania. Discuss the range of sciences used within each application. Ask the learners to identify three applications that they might find interesting. Learners can then generate questions they have about one of these.

- Organise a class discussion with a scientist to discuss how they work to further the understanding in their field, the science that it relates to and the equipment they use. Learners reflect on what they might want to know more about in the scientist's field of study.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information.

- Learners undertake a short, structured inquiry related to a provider supported focus. Learners step though the inquiry process and how to use the structure of the logbook to aid in recording and analysing data and information, creating science-based explanations, and evaluating conclusions.
- Learners research the problems Tasmanian scientists are helping to solve related to their area of study. Use this information to narrow the possible inquiry questions for each learner.
- Learners choose from a provided range of focuses and are given a list of scientific applications conducted in Tasmania related to that focus. Learners can then research two or three applications to further understand the science involved and how its applied.

The how for learners

These activities describe how to support learners to create, transfer and deepen knowledge and understanding.

- Learners trial methodologies to investigate their possible inquiry question using a set of resources common to the class. By analysing these trials and their links with scientific understanding learners plan their inquiry.
- Where appropriate learners reference First Nations Tasmanians' knowledge which can aid in understanding the context for their possible inquiry. This knowledge may be useful for the context or scientific understanding of the systems investigated.
- Learners experiment with different ways to represent their data and information. What variables can they measure? What might it tell them? Which are the dependent and independent variables? How are they related? How do they relate to the possible inquiry questions?
- Learners plan a rough set of investigations for their inquiry and share it with peers for feedback. Once this feedback has been addressed, the teacher can assist and support the learner to develop a risk management plan. The learner can then consult with the laboratory manager.

Module 1: Focus area guidance

Engage and ideate

- Learners, using their prior knowledge, will engage with and ideate a focus of inquiry that is relevant to their community.
- Learners will discover that in practice science draws from many scientific disciplines.
- The emphasis will be on the Tasmanian context with links to national and global contexts.

Connect and apply

- The value of the scientific focus in Tasmania, nationally and globally will be understood through research, analysis and iterative inquiry.

- Learners create knowledge and understand the interrelationships between theories, models and methodologies.
- The application of a system through inquiry, analysis and refinement of scientific understanding at every stage is key to this module.
- Learners should prepare to question their work and evaluate earlier work to ensure they build the interrelationships between their knowledge and the system they are focusing on.

Exhibit and reflect

- In this module, trialling and evaluating processes and methodologies is crucial to prepare for further inquiry.
- Through this process possible lines of inquiry will emerge to be further analysed and refined in Module 2. Learners will have the opportunity to demonstrate their findings and plans through a folio.
- Learners will then evaluate their understanding and analysis to choose a focus, and plan, for further investigation in Module 2.

Module 1: Recommended resources

- Providers offering this course will need equipment, materials and a suitable space to carry out the practical component of the course effectively and safely.
- Field Study Centres - The Department of Education Tasmania
- Aboriginal Education Services (Aboriginal Education Services, 2021).
- Motivation and ideas for inquiry can be generated through the 2030 Sustainable Development Goals (United Nations, 2021).
- Bayram, Z. & al, e., 2013. *Effect of Inquiry based Learning Method on Students' Motivation*. Procedia - Social and Behavioral Sciences, Volume 106, pp. 988-996.
- Inquiry-based learning (Department of Education, Skills and Employement, 2021).
- Enquiry-based learning (Griffth University, 2021).
- Keiler, L. S., 2018. Teachers' roles and identities in student-centered classrooms. *International Journal of STEM Education*, Issue 5.
- Assessment in inquiry-based learning (OPHEA, 2021).
- 5 Ways to Get the Most Out of Student Portfolios (Spencer, 2020).
- Discover, Discuss, Demonstrate: Using Inquiry-Based Learning to Keep Students Engaged (Stephanie Rothstein, 2021).
- Communities of Practice may provide additional resources.

Module 2: Conduct, monitor and refine

The following learning outcomes are a focus of this module:

1. collaborate with others and monitor, critically analyse and manage their own learning within a scientific inquiry
2. design and conduct ethical and safe collection and analysis of data within a specific application of science to inquire into a system

3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability
5. apply the context of their inquiry locally, nationally and globally and explore relationships between technology, science and the broader community for a particular scientific application
7. analyse, refine and finalise experimental design for an inquiry as they collect and analyse data, undertake further research and monitor progress, underpinned by an iterative approach

Module 2: Teaching strategies

Teachers will need to rely on the established skills, knowledge, processes, and planning developed in the first module. Learners will have much more responsibility for evaluating and maintaining their own progress. Teachers will guide learners as they continue with an achievable inquiry.

Regular structured time is required for learners to add to and evaluate their understanding of the science, methodologies and interrelationships that underpin their inquiry. These processes should follow those set up in the first module. Ongoing self, peer and teacher assessment should be used to maintain progress and continual analysis.

Teachers support learners as they refine and finalise their inquiry question with reference to the methodologies, scientific understanding and interrelationships discovered. Together with the finalised context for the inquiry, this will be documented when addressing the Finalised inquiry question and context work requirement. This work requirement forms the first component for the externally assessed folio. A shared digital logbook is useful to track and support learners' progress with comments, questions, or suggestions.

Expectations should be scaffolded by using the Quad chart and future plans presentation work requirement. While preparing for this work requirement, learners can experiment with different methods of presenting the data and information they have generated to best represent the progress of their inquiry. This will be useful for reflecting on their progress and preparing them for the final module.

Module 2: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections.

- Learners continue to investigate the importance of the science related to their inquiry for Tasmania and the issues that accompany it. Through this process they can start to refine the context and make connections with similar science and issues nationally and globally.
- Learners continue to research, apply and evaluate the scientific understanding that underpins their inquiry. They analyse the interconnections between disciplines and record any questions that may arise. What further understanding do I need? Are there any other studies that could help the inquiry?
- Learners share and refine their plans with others in the class with similar inquiry questions or processes. Through Module 2 they can evaluate their progress and what they have learnt about all aspects of their inquiry to suggest refinements to each other.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information.

- Learners identify and make refinements to their knowledge and practice as they collect and reflect on their data. Are there gaps on the data? Are there unexpected results? How can these be explained? What changes to the methodologies will improve the inquiry?
- Connect learners, in-person or online, to a scientist or other expert working in a similar area. The learners can use this to learn more about what is important as they refine their inquiry question.
- Learners make detailed qualitative observations in relation to the collection of data. This may include video or photographic evidence. This information should be used as evidence when evaluating why data collected is not identical to ideal scientific modelling.

The how for learners

These activities describe how to support learners to create, transfer and deepen knowledge and understanding.

- Learners refine ways to represent the data and information they have generated to demonstrate what they have found and what still needs further investigation. If using a spreadsheet to assist include this new data as it is generated for interpretation.
- Learners analyse and refine their scientific understanding to explain the data as they collect it. They use their logbook to reflect on what scientific understanding is most suited to explaining their findings while other explanations are less relevant.
- Learners use the refinement processes to plan for the collection of the last sets of data in the next module. What is the purpose of these processes? Is it gaps in the data? Is it to confirm their current dataset? Has something else emerged that needs testing in relation to the finalised inquiry question?
- Learners finalise their inquiry question and context for their study to be included in their externally assessed folio at the end of module 3.

Module 2: Focus area guidance

Engage and ideate

- As the inquiry progresses learners will take more responsibility to monitor, evaluate and refine all aspects of their inquiry.
- This module provides an opportunity for the learner to engage more deeply with the focus of inquiry and the interconnections that emerge.
- Learners will finalise their inquiry question and the processes used to pursue it. They will do this through further targeted research, reflection, and investigation into this focus.

Connect and apply

- By applying theories, models and methodologies they will be able to refine the connections they have already made to support their extended inquiry.
- The application of science through inquiry, reflection and refinement of understanding at every stage is key to this module.
- Learners should always question their work and return to earlier work to ensure they are able to build their knowledge and narrow the focus of the inquiry.
- Learners will finalise the local, national and global context explicitly outlining important interconnections and the evidence they have for these.

Exhibit and reflect

- In this module, monitoring and evaluating processes and methodologies is crucial to prepare for further inquiry.
- Learners will finalise, for external assessment, their justified inquiry question and their analysis of local, national and global context through the finalised inquiry question and context work requirement.
- Learners will reflect on, at a system level, summarise and present their progress at the end of module 2 through the Quad chart and future plans presentation work requirement.

Module 2: Recommended resources

In addition to resources listed in module 1 and 2, the following resources are recommended:

- External Assessment Specifications for *Transdisciplinary Science* Level 3.

Module 3: Review, represent and recommend

The following learning outcomes are a focus of this module:

1. collaborate with others and monitor, critically analyse and manage their own learning within a scientific inquiry
2. design and conduct ethical and safe collection and analysis of data within a specific application of science to inquire into a system
3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability
5. apply the context of their inquiry locally, nationally and globally and explore relationships between technology, science and the broader community for a particular scientific application
8. collate and analyse the key data and findings from an extended scientific inquiry and make recommendations for further study.

Module 3: Teaching strategies

Above all, the focus of this module is on analysis and representation of understanding at a system level. Learners need to analyse the interconnections between all aspects of their inquiry. Practical work will finalise answering the inquiry question where possible. Analysis and plans for further study should be completed where the question remains unanswered.

Use the specifications for the work requirements and external assessment specifications to plan for explicit teaching. Provide checkpoints for learners to assess their progress. Teachers should encourage learners to focus their time on the more challenging aspects of these. These include:

- summarising, representing and interpreting data from the inquiry
- analysis leading to conclusions
- suggestions for further investigation.

The creation of a formal scientific paper and a poster will require some explicit teaching and monitoring. Use the regular processes established earlier in the course and the logbook to document progress and self-reflection. Provide opportunities for peer and teacher comments and suggestions.

Communicating understanding is more important than meeting a word count. The scientific paper can be in any mode or modes that convey the information needed. Where appropriate encourage learners to use accepted scientific formats in place of words. For example:

- diagrams
- data tables
- graphs
- statistical analysis
- algebraic modelling.

The poster should include concise, large font, statements to assist others with interpreting the diagrams, charts and images and other visual representations rather than large blocks of text. Learners should have the opportunity to practice the presentation and defence of their poster. Try and make this as close as possible to the conditions of external assessment. Allow time for feedback and changes to be made to the learner's work.

Module 3: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections.

- Learners can reflect on feedback from their Quad chart presentation. They should know how to represent what they have found to date more effectively. What needs to be done to provide clear evidence and explanations?
- Learners review the work they have recorded in their logbook using with their own, peer and teacher reflections to make further connections. Is there something that makes sense now that didn't before? Have they missed something?
- Learners plan their time for module 3 so they have time to work through any areas of need within their inquiry. For example, finalising their overall data analysis to make reasoned evidence-based conclusions.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information.

- Learners analyse the data to see where it fits within the inquiry as they collect their final data. Is this data collection serving the intended purpose or is it posing more questions? What might need to go into possible further investigations in the paper?
- What scientific knowledge and models describe what learners have found? How are these best represented? With a diagram, a series of images or another representation? How can the connections between the inquiry and science be explained?
- Learners evaluate their data and information for any limitations that may have affected the inquiry overall. Were they unavoidable in the inquiry, for example, limitations in accuracy of measuring equipment? Could they be avoided in a future investigation?

The how for learners

These activities describe how to support learners to create, transfer and deepen knowledge and understanding.

- Challenge learners to create a scientific paper that only includes the most important data and information without ignoring important parts of the inquiry. The paper needs to allow external assessors to understand what has been found. Readers should be able to replicate the inquiry from the paper.
- Challenge learners to create a poster that contains the essence of the inquiry and what it has found without an overload of information. Each figure should be clear and able to be understood in isolation. The poster should be designed to be presented in 3 minutes with additional details to show the depth of the inquiry.
- Encourage learners to use each other, their teacher and any other person that may be able to help in completing this module. This is particularly important for the presentation of the poster. Learners should practise this presentation with trusted others before external assessment.

Module 3: Focus area guidance

Engage and ideate

- Significant time should be given to analyse, communicate and evaluate the inquiry as a whole and organise their folio to reflect this.
- A gap analysis should be undertaken and data collection completed.
- Learners complete any further investigation or research required to support answering their inquiry question

Connect and apply

- By applying the most relevant theories, models and methodologies, learners will be able to make the connections required to develop valid and evidence-based conclusions for a describable system.
- Learners ensure all the interrelationships within the inquiry relate to inquiry question and can be clearly represented.
- The drafts of scientific paper and poster should be evaluated as they are produced to be as clear and coherent as possible and relates directly to the inquiry question.

Exhibit and reflect

- Learners should be clear about how the externally assessed portfolio is to be presented and assessed. As items are completed, they should be collated within the structure.
- While completing the scientific report the structure of the scientific paper work requirement should be closely followed to assist with external examination.
- The poster should be designed with both the requirements of the poster work requirement and the external oral exam in mind. Opportunities to present, receive feedback and adapt the poster should be available before the externally examined presentation and defence.

Module 3: Recommended resources

In addition to resources listed in module 1 and 2, the following resources are recommended:

- 10 Tips on Writing a Research Poster
- Tips for presenting your scientific poster at a conference
- 7 Steps for Writing a Scientific Report To Share Research Results

Supporting learner responses

The work requirements outlined in the course document describe the fundamental assessment evidence. Inclusion of other tasks may support and enhance learning. Learning activities aim to support and enrich understanding and achievement of the learning outcomes. Possible strategies to support learner responses to a work requirement for each module are provided. Additional work requirements are outlined in the course document.

Module 1: Research, trial and plan

Work requirement 2 of 2

Title: Research and Plan

Context

Learners have explored inquiry processes with a particular focus on what is required to plan a scientific inquiry for a period of 8 weeks. Additionally, they may have undertaken/participated in excursions, incursions or expert discussions.

Learners will create a research outline which allows the learner to demonstrate that they have an achievable plan to complete a transdisciplinary science inquiry within the scope of this course. The design of the content and logbook for this module leads learners to this point. Guidance is provided by the mandatory Inquiry project approval procedures.

Relevant learning outcomes

1. collaborate with others and monitor, critically analyse and manage their own learning within a scientific inquiry
2. design and conduct ethical and safe collection and analysis of data within a specific application of science to inquire into a system
3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability
5. apply the context of their inquiry locally, nationally and globally and explore relationships between technology, science and the broader community for a particular scientific application
6. analyse information they have researched to implement and adapt processes and trial methodologies while inquiring into a system

Scaffolding

- This work requirement provides the main evidence needed to meet the Inquiry Project Approval Procedures to be submitted to, signed off and kept by the teacher.
- The structure of the logbook should support this work requirement and work requirements for future modules.
- Learners should practise, trial and generate evidence to complete this task. Documenting what they have learnt so far and their plans for their inquiry.
- Teaching of how to represent, analyse and evaluate data and information will be required to support learners.

- Regular self, peer and teacher reflection during this initial module will prepare learners to complete this task.
- Although a word limit is specified, encourage learners to use other accepted scientific representations in place of words where appropriate.
- The annotated bibliography is only required for the most important sources of information.

Module 2: Conduct, monitor and review

Work requirement 1 of 3

Title: Logbook

Context

The logbook is a record of observations, data, reflection and learning for the entire module. In this module the learner is taking greater responsibility for their learning with the logbook as the central record. Create the logbook in an exercise book, a loose-leaf folder, or an online platform such as OneNote. A digital record makes it easier to record, reorganise and evaluate ongoing work as well as facilitating self, peer and teacher assessment.

Relevant learning outcomes

1. collaborate with others and monitor, critically analyse and manage their own learning within a scientific inquiry
2. design and conduct ethical and safe collection and analysis of data within a specific application of science to inquire into a system
3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability

Scaffolding

- In this module learners, although supported, have much greater responsibility for their learning. Scaffolding should guide learners and provide opportunities for analysis and evaluation.
- The logbook should have sections that support the learners to record, reflect on, and reorganise their work with sections such as:
  - » planning
  - » monthly log
  - » running annotated bibliography
  - » research notes
  - » observations and data
  - » emerging relationships and interrelationships
  - » analysis and evaluation
  - » log of time on task
  - » peer and self-assessment
  - » teacher feedback.
- Learners should have in mind that they need to finalise their inquiry question and context by the end of this module.

- Data collection should be largely completed by the end of the module.
- Provide regular opportunities for learners to evaluate and reorganise their work, find gaps as well as interrelationships.
- Schedule regular self, peer and teacher feedback to ensure learners are progressing well.
- Regular opportunities to refine the contextual information and the supporting scientific models and theories are essential.

Module 3: Review, represent and recommend

Work requirement 3 of 3

Title: Poster

Context

Learners have explored finalising their inquiry with a particular focus on completing outstanding data collection for a period of 4 weeks. Together with the authoring of a scientific paper the poster will require the remaining 7 weeks of the module.

The learner will replicate the common process of a poster presentation accompanied with a defence by answering questions. The poster should represent the major evidence and findings of the inquiry without an overload of information.

Relevant learning outcomes

3. analyse and discuss concepts and processes from scientific theories and models to inquire into a system
4. communicate data and information using standard scientific conventions for qualitative and quantitative representation, and evaluate their reliability
8. collate and analyse the key data and findings from an extended scientific inquiry and make recommendations for further study.

Scaffolding

- Learners will need explicit guidance for producing the poster.
- The poster and presentation are a celebration of what learners have achieved in the year.
- Learners need to convey the major evidence and the outcome of their analysis for the poster.
- Text should be concise and in large font.
- Diagrams, charts, and images should convey the bulk of the data and information.
- Follow the guidance from this work requirement and the external assessment specifications.
- Although not part of this work requirement, learners should practice and receive feedback on their presentation to prepare for their external assessment.
    - » The audience needs to consider:
        - Asking questions that allows learners to demonstrate the depth and extent of their learning.
        - Questioning learners to discern what they understand rather than gaps in their knowledge and skills.

  - Teachers, and peers, should ask questions about the presentation and meaning of information and data.
- An image of the poster to be presented for external assessment is part of the folio to be submitted.

Additional support resources [3]

- Course Document
- Sample Scope and Sequence
- Community of Practice Information
- External Assessment Specifications
- Inquiry project approval procedures – See Appendix 7 of the course document

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[3] All resources cited were accessed and checked for accuracy and appropriateness of content in October 2022. Teachers should check the suitability of all recommended resources for their specific group.

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