CREST Teacher Handbook

Creativity in Research, Engineering, Science and Technology

Contents

CREST Overview

Creativity in Research, Engineering, Science and Technology (CREST) is an educational program made available by CSIRO for teachers and students to develop and improve their science, technology, engineering, and mathematics (STEM) skills. CREST supports teachers to facilitate inquiry learning in the classroom and provides scaffolded resources to enable students in Years K to 12 to undertake a science investigation or a technology project.

CREST Awards have been designed as an incentive to recognise student progress and achievement in inquiry learning. There are six award levels: Green, Orange, Blue, Bronze, Silver and Gold. The awards are competency-based and are non-competitive. Students conducting a CREST inquiry may work alone or in a team of up to three students (*further information on student team sizes is addressed on Page 17 of this handbook)*.

Background

CREST provides over 20 years of experience working scientifically with teachers and students, with an aim to encourage students to learn the skills of STEM research. CREST is based on a student-centred pedagogy referred to as inquiry learning. Inquiry learning encompasses a process of engaging students to seek out topics of interest to develop in-depth knowledge and understanding. Opportunities to participate in inquiry learning empowers students to:

take responsibility for their learning

identify and define a problem

formulate meaningful questions to explore a problem

design an investigation to find an answer or solution to a problem

interpret evidence, form logical explanations, and communicate their findings.

CREST provides meaningful contexts for students to develop, practise, and apply their general capabilities including critical and creative thinking, ethical understandings, personal and social capabilities, literacy, and numeracy skills.

CREST is aligned with the Australian Curriculum and integrates the Science Inquiry Skills and Design and Technologies Processes and Production Skills of the Science and Design and Technologies learning areas.

CREST and the Inquiry Process

CREST recognises that all learners (teachers and students) have a variety of skills and attributes that will determine what stage of inquiry learning is appropriate to begin with in the classroom. The Inquiry Continuum (*see Table 1*) provides an overview of the different inquiry learning stages: **Limited**, **Structured**, **Guided** and **Open**. Providing students with experiences to conduct limited, structured, and guided inquiries develops their procedural knowledge and skills required for independent and innovative open inquiry.

Table 1: The Inquiry Continuum

Limited	Structured	Guided	Open
• Learners engage with teacher-determined questions • Learners may be given data, or collect it & are instructed in methods of analysis • Learners are provided with evidence • Learners are given steps & procedures for communications	• Learners clarify questions provided by teacher or teacher-provided materials & sources • Learners are directed to collect specific data • Learners are presented with means to use evidence in explanation • Learners are given connections to other ideas • Learners are scaffolded to develop communication	• Learners select questions from provided options • Learners are guided to collect data • Learners are guided to form explanations from evidence • Learners are directed towards sources of scientific ideas • Learners are coached in the development of communication	• Learners propose & pursue their own questions • Learners determine what constitutes evidence & a method to collect it • Learners formulate explanation from evidence • Learners examine other resources & link ideas to evidence • Learners formulate reasonable & logical arguments to communicate explanations

The Inquiry Continuum starts with *Limited* inquiries– this is where a student would conduct an activity to validate a principal (i.e. an investigation where the question, procedure and outcome is known in advance). A *Structured* inquiry is where a teacher would present an inquiry question or scenario, but reduces the information provided to students (i.e. the procedure is prescribed but the outcome is unknown). A *Guided* inquiry is where students are again provided with an inquiry question but further required to design their own procedures. An *Open* inquiry is where a student transitions from teacher-directed investigation to student-directed inquiries (i.e. the student demonstrates all inquiry skills from the Science or Technology strands of the Australian Curriculum and uses critical and creative thinking to explore big ideas and topics).

Starting your CREST Journey

CREST provides *structured* and *guided* inquiry activities for teachers to facilitate inquiry learning with their students. Teachers can choose either a science investigation or a technology and engineering project to conduct with their students. Ways to incorporate CREST will depend on individual school structures. The following approaches have been used successfully by CREST teachers:

as an integral part of the class work program and an option for assessment

as a part of a Science Inquiry Skills unit in primary or junior secondary science

as a major project in senior science classes

as a major unit of work in extension classes (or as an alternative to a research assignment)

as a whole subject in a vertical curriculum

as an extra-curricular or after-school club activity

CREST Online

CREST inquiries and additional CREST resources are accessed via CREST Online. Teachers new to CREST will need to register as a *new user* or check to see if their school is *already registered*. Instructions on how to check can be found using the FAQ link on the home page: https://crest.csiro.au/CrestOnline/Faq

Additional CREST Resources

Additional resources and support materials for teachers and students are available via CREST Online, including:

- Teacher and Student guidance for CREST Inquiries
- Planners – required for Intermediate and Advanced CREST Inquiries
- Checklists
- Rubrics
- CREST Proposals – required for Advanced CREST Inquiries

CREST Awards

There are three categories for CREST Awards: **Introductory**, **Intermediate**, and **Advanced**. The nature of the inquiry conducted corresponds to the six CREST Awards: *Green, Orange, Blue, Bronze, Silver and Gold*.

GREEN ORANGE BLUE BRONZE SILVER GOLD

CREST Awards are competency-based, and teachers may choose the most applicable inquiry level to suit their students' abilities. It is not compulsory for a student to have completed a specific award before choosing a different award. For example, a student can progress from a Blue Award to a Silver Award without needing to have completed a Bronze Award.

Introductory CREST Awards

CREST Awards for this category are Green and Orange

Green inquiries are designed to suit a *structured* style of inquiry

Orange inquiries are designed to suit a *guided* style of inquiry

Requirements for an Introductory CREST Award and the roles, responsibilities and activities expected from students and teachers in undertaking the investigation/project are outlined below.

GREEN	ORANGE
STUDENT JOURNEY:	
Student follows inquiry instructions provided making limited choices to conduct the inquiry.	Student follows inquiry instructions making decisions on what procedures to follow.
Undertakes background research to build their knowledge and understanding of related ideas.	
Can work alone or in a team of up to three students.	
TEACHER JOURNEY:	
Teacher to choose a CREST Inquiry from CREST Online under Download materials → Introductory tab. Additional support materials including Checklists, Rubrics, Teacher and Student Guidance are available via CREST Online.	
Teacher assesses student inquiry – no report submission to CREST Team required.	
Once inquiry is completed, teachers can download and print certificates from CREST Online and order the exact number of stickers for the award level. Stickers are posted to the school and need to be affixed to authenticate the certificates for students.	

Intermediate CREST Awards

CREST Awards for this category are Blue and Bronze

Blue and Bronze inquiries are designed to suit an *open* style of inquiry

Requirements for an Intermediate CREST Award and the roles, responsibilities and activities expected from students and teachers in undertaking the investigation/project are outlined below.

The student and teacher need to decide on the type of award looking at two elements. Whether it is:

1. **Science** or **Technology/Engineering** type work

Science Investigation	Identify a scientific question which is of interest to them
	Decide on how they will answer the question
Technology and Engineering Project	Identify a real-world problem which is of interest to them
	Decide on how they will solve the problem

2. **Blue** or **Bronze** Award level

There are many similarities shared between the **Blue** and **Bronze** levels. The table below shows the distinct differences and similarities between them.

BLUE	BRONZE
STUDENT JOURNEY:	
1. Choose a topic. 2. Conduct background research to build knowledge and understanding of related ideas. 3. Plan an investigation/project to be approved by the teacher using the *Intermediate CREST Awards Science Investigation Project Planner or Technology and Engineering Project Planner.* 4. Undertake the investigation/project, records results and maintain a log book. 5. Meet with the teacher regularly to discuss progress and receive feedback. 6. Once investigation/project is finalised, student completes the '*Explaining your results'* section on the planner.	
Take at least 4-10 hours to complete, from initiation of the inquiry to the completion of the final report, within a 12-month period.	Take at least 10 hours to complete, from initiation of the inquiry to the completion of the final report, within a 12-month period.
A log book, tracking inquiry activities and time spent undertaking the investigation is recommended. The log book should detail the date, time and activities undertaken and cumulative time spent on the investigation.	
Students may work alone or in a team of up to three students.	
To be eligible for an Intermediate CREST Award, students must demonstrate a *Consolidating* or *Achieving* standard on all criteria listed in the Blue/*Bronze CREST Award Science Investigation Evaluation Rubric or Technology and Engineering Project Evaluation Rubric.*	

TEACHER JOURNEY:
Give feedback to the student on their ideas for the investigation and provide scaffolds as necessary.
Ensure that the investigation/project has been assessed for risk and is considered to be safe and ethical or mitigate any potential risks with appropriate strategies outlined in a plan.
Approve the students' plan for the investigation/project as prepared using the *Intermediate CREST Awards Science Investigation Project Planner or Technology and Engineering Project Planner.*
Consider using the optional *Intermediate CREST Award Checklist* to monitor student progress, maintaining a continuous record of the students' investigation.
Assess the work and confirm that it demonstrates a *Consolidating* or *Achieving* standard on every criterion listed in the *Intermediate CREST Award Science Investigation or Technology and Engineering Evaluation Rubric.*
Submit the *Blue/Bronze CREST Award Science Investigation/Technology and Engineering details* to the CREST Awards team for processing through the CREST Online Portal using the **specifically named** spreadsheet via CREST Online.   Please complete every field with sufficient information for the CREST Awards team to understand the investigation/project   Please allow four weeks (20 working days) for the investigation to be processed.
A Blue/Bronze CREST Award certificate can be requested from CREST Online, a pdf file containing the formatted certificates will be emailed to the teacher. For ordered medallions these will be posted to the teacher to be distributed to student(s).

Advanced CREST Awards

CREST Awards for this category are Silver and Gold

Innovation is a mandatory component for Advanced CREST Awards. CREST defines innovation in two components: the element of originality and the element of unique real-world* application

Silver inquiries demonstrate an *open* style of inquiry, that features an *original <u>or</u> unique real-world application*

Gold inquiries demonstrate an *open* style of inquiry, that features both an *original <u>and</u> unique real-world application*

Requirements for an Advanced CREST Award and the roles, responsibilities, and activities expected from students and teachers in undertaking the inquiry are outlined below.

The student and teacher need to decide on the type of award looking at two elements. Whether it is:

1. **Science** or **Technology/Engineering** type work

Science Investigation	Identify a scientific question and design an innovative Science CREST Award Investigation. Decide on how they will answer the question.
Technology and Engineering Project	Identify a real-world problem and design an innovative Technology/Engineering CREST Award Project. Decide on how they will solve the problem.

2. **Silver** or **Gold** Award level

There are many similarities shared between the Silver and Gold levels.

The table below shows the distinct differences and similarities between them.

SILVER	GOLD
STUDENT JOURNEY:	
Choose a topic and conduct background research to build knowledge and understanding of related ideas.	
Topic must show originality <u>***or***</u> unique real-world application.	Topic must show originality <u>***and***</u> unique real-world application.
Read the relevant Advanced Science or Technology/Engineering Rubric and ensure that all criteria can be addressed at the consolidating level.	
OPTIONAL: Student and teacher to source an external mentor for investigation/project.	**MANDATORY**: Student and teacher to source an external mentor for investigation/project.
Prepare a CREST proposal using S*ection B* of the *Advanced CREST Award Project Planner.* It then needs to be approved by the teacher using *Section C and* emailed by the teacher to the CREST Awards team for approval prior to start of work.	

Take 30 hours minimum to complete, from initiation of the inquiry to the completion of the final report, within a 12-month period.	Take 100 hours minimum to complete, from initiation of the inquiry to the completion of the final report, within a 12-month period.

Maintain a log book, which should detail the date, time and activities undertaken, and **cumulative** time spent on the investigation.
Communicate regularly with their teacher to discuss their progress and receive feedback.
Complete and submit *section D* of the *Advanced CREST Project Planner for the* final investigation summary report, and log book to the teacher to ensure award criteria are met, teacher to forward the summary to the CREST Awards team for assessment.
Students may work alone or in a team of up to three students.

TEACHER JOURNEY:

There is a two-stage submission process:

- **Teacher submits student proposal document before inquiry starts**
- **Teacher submits student final summary report and log book.**

Ensure that the mandatory background research has been done to show how the proposal meets the component/s of innovation.

Ensure that if an external mentor is involved, that they have a valid **Working with Children check**. All phone or video correspondence should be in the presence of a teacher or a parent/guardian. Any email correspondence needs to be carbon copied (Cc'ed) to the teacher.

For Gold CREST, ensure that an external mentor is engaged (*see Engaging a Mentor section in this handbook for additional information about mentor criterion*).

There is no specific minimum number of hours that the mentor needs to be engaged apart from at least one crucial engagement that should happen during the project proposal phase to ensure that the project features an *original or unique real-world application* and has not been performed by others in the past.

Ensure that the investigation or project has been assessed for risk and is considered to be safe and ethical, or that any potential risks are mitigated with appropriate strategies outlined in the proposal document.

Approve the students' proposal and email it to the CREST Awards team for approval (crest@csiro.au), using the appropriate *Advanced CREST Award Project Planner, Section B.*

Consider using the optional appropriate *Advanced CREST Award Checklist* to monitor student progress, maintaining a continuous record of the students' investigation.

Check that the work demonstrates a *Consolidating* or *Achieving* standard on every criterion listed in the relevant *Advanced CREST Evaluation Rubric before submitting the final summary report, including the log book to CREST via email.*

If the investigation has been assessed as meeting the minimum standard, an Advanced CREST Award certificate can be requested from CREST Online and this will be emailed to the teacher. A medallion will be posted to the school. *(If the criteria and standards for the Advanced CREST Award are not met, a Bronze CREST Award will be issued.)*

Please allow 20 working days for the investigation to be assessed.

*Originality and real-world application

Originality may be demonstrated in:

- The development and testing of a novel hypothesis
- The application of an established method to a new context
- The use of a novel or modified method in an established context
- A modified and improved device

A novel hypothesis extends upon or challenges an existing or established scientific hypothesis in some describable way.

A novel method should have some value absent from the established method: it should save time or money, be more efficient in some way, or be easier or more replicable or useful when there are limited resources available.

Originality may be demonstrated by explaining what other hypotheses, methods, or devices exist using no less than five different reliable and credible sources. An online search should not reveal that the hypothesis, method, or device has already been developed and tested.

Real world application describes a specific, relevant, and plausible application of the findings of the investigation to a problem or context in the real world. The problem or context should not be better addressed or solved by otherwise available products or applications. The findings should be beneficial to the user and/or larger groups of people, or to the environment, in a local, national, or global setting.

Engaging a Mentor

Optional for Silver CREST Award

Mandatory for Gold CREST Award

Mentor must hold a valid **Working with Children Check**

An external mentor could be any one or more of the following descriptions:

An expert advisor (particularly around the notion of innovation in the inquiry)

A source of research information and articles

A provider of necessary resources and equipment

An instructor in sophisticated procedures or the use of specialist equipment

A sounding board for ideas

Being a mentor is an enjoyable and worthwhile experience. Mentors make a valuable contribution to the development of a student in a way that challenges and rewards that student, extending the boundaries of their education beyond the classroom. Mentors may talk to students about the context of their own work or organise a visit to their work site. Through these interactions, students may see opportunities to develop or refine their own project interests.

CREST recognises students' creativity in solving theoretical, practical, and real-world problems. If this is to be demonstrated, there is a delicate balance to be achieved between nurturing and supporting rather than directing or leading. A mentor's role is one of encouraging students to come up with their own ideas and of giving constructive feedback or exploring practical alternatives.

In short, a mentor's role is to help students to do what they want to do, without telling them what to do.

Please note that the student's teacher or parent/guardian must be present or Cc'ed in all communications. A parent/guardian would be expected to supervise any work-site visits.

A final note on Mentors:

External mentor – must be from industry, a university academic (Honours and Higher STEM related Degree, Research candidates are acceptable) or a retired professional with a relevant background.

A post graduate educational qualification such as a Masters in Education, does not fulfil the requirement. Hence, the mentor should preferably be external to the school staff.

Please note – the CREST Team currently does not source mentors for students.

CREST Award Validation

CREST Awards recognise students' inquiries in a non-competitive, competency focused program, from structured through to open inquiry, with certificates and medallions.

Certificates and Medallions

Introductory and Intermediate CREST Awards are assessed by each student's teacher, using a CREST Awards Evaluation Rubric. Once a teacher has confirmed that all criteria (competencies) have been demonstrated at the required minimum standard, the CREST Award is granted to the student. Teachers can download Green and Orange certificates via CREST Online, but need to be validated with the relevant coloured CREST Award sticker. These can be ordered through CREST Online. For Blue and Bronze, teachers can enter student details via CREST Online and request certificates, these will be emailed to the teacher.

Advanced CREST Awards are assessed by the CREST team. Students are required to prepare a proposal outlining their inquiry, which teachers should submit to the CREST team for feedback. Once the inquiry is completed, teachers need to submit the final report and log book for that award to the CREST team for assessment. The team will confirm that all criteria have been met at the required standard to approve the CREST Award. This process is supported by an Advanced CREST Awards Evaluation Rubric. For Silver and Gold, teachers can enter student details via CREST Online and request certificates, these will be emailed to the teacher.

Using Checklists and Rubrics

Checklists are provided for students and teachers (and mentors, if engaged) to track progress and record notes and feedback regarding an inquiry. The use of the checklist is **optional,** and they are not required to be submitted.

Rubrics describe the criteria and standards by which CREST Award inquiries are assessed. At the Introductory and Intermediate CREST Award levels, the rubric provides guidance for the teacher in assessing the CREST Award (separate or extended assessments may be made for classroom assessment purposes, as necessary and appropriate). A rubric is also used by the CREST assessment team in assessing Advanced CREST Award applications. Rubrics may be discussed with students at the beginning and throughout their inquiries, to provide feedback and guidance for improving work and progressing through the inquiry.

Ineligible Award Proposals

All projects must conform with State and Federal laws and regulations as well as the individual school regulations; the former shall take precedence.

Ineligible CREST categories include:

Testing of any type of drugs at any concentrations. Besides illegal drugs, all legal drugs such as caffeine (e.g. from high energy drinks to dilute coffee) are not permitted.

Testing and/or design of firearms and/or explosives.

Unethical behavioural testing involving human and/or animal subjects (e.g. determining a person's attractiveness based on 'prettiness' or 'ugliness'). This is a breach of ethics standards.

Arbitrary/subjective psychology experiments where results are not reliable or are very inconsistent (e.g. do dogs make people happy). Such an experiment would need to result in a P value of 0.05 or lower for it to be statistically significant.

Please note:

The first 3 categories are banned in all CREST Award levels. Psychology type experiments are currently permitted for Introductory and Intermediate CREST Awards only.

If additional clarification is required on a subject matter regarding safety or ethics, teachers can refer to Science ASSIST via https://assist.asta.edu.au/.

CREST Awards Framework

	INTRODUCTORY		INTERMEDIATE		ADVANCED	
Nature of the inquiry	Structured	Guided	Open	Open	Open and innovative (**Either** original or unique real-world application)	Open and innovative (**Both** original and unique real-world application)
Award	Green	Orange	Blue	Bronze	Silver	Gold
Anticipated time to complete	2-5 hours	2-5 hours	4-10 hours	>10 hours	>30 hours	>100 hours
Stimulus to inquiry	CREST materials or other relevant materials approved by the CREST team	CREST materials or other relevant materials approved by the CREST team	CREST materials or other relevant materials, or student-generated question	Student-generated idea or question	Student-generated idea that is original **OR** uniquely addresses a need	Student-generated idea that is original **and** uniquely addresses a need
Investigation design	Structured three-part lesson including preparation, investigation, and evaluation	Partially structured with opportunities for student decision-making or interpretation	Largely determined by student, guided by the teacher, scaffolded by CREST materials	Designed and undertaken by the student, scaffolded by CREST materials and teacher feedback	Designed and undertaken by the student with teacher feedback	Designed and undertaken by the student with teacher and external mentor feedback
Practical application	Embedded if present	Embedded if present	Optional	Recommended	Recommended	Required
Feedback on investigation plan	Teacher	Teacher	Teacher	Teacher	Available from CREST Team	Required by external mentor and CREST Team
Evaluation of completed investigation	Teacher, student	Teacher, student	Teacher, student	Teacher, student	Supervising teacher, student, and CREST Specialist	Supervising teacher, student, and CREST Team

External mentor	Optional	Optional	Optional	Optional	Recommended	Required
Teacher role and responsibilities	• Direct students through the investigation • Develop explanations for or with students	• Structure the investigation for and with students • Develop explanations with students	• Stimulate the inquiry • Facilitate students as required	• Facilitate students as required	• Facilitate students as required	• Facilitate students as required • Assist students to identify and work with an external mentor
Mentor role and responsibilities	• Engage with students' questions • Support the teacher to facilitate the inquiry	• Provide constructive feedback to students' decisions, explanations, and communication • Support the teacher to facilitate the inquiry	• Develop, suggest, or provide stimuli for student inquiry • Provide constructive feedback to students • Support the teacher to facilitate inquiry	• Provide constructive feedback to advance the inquiry • Support the teacher to facilitate the inquiry	• Supervise students if required • Provide constructive feedback to advance the inquiry • Support the teacher to facilitate the inquiry	• Supervise students as required • Provide constructive feedback to advance the inquiry
Student preparedness: confidence and competencies	Students can, with confidence: • Conduct the investigation as directed	Students can, with confidence: • Make decisions about the procedure as appropriate but otherwise conduct the investigation as directed • Make decisions about how to represent the data • Develop explanations with the teacher	Students can, with confidence: • With guidance, identify a research question or problem • Develop a plan for investigation • Interpret and communicate the results	Students can, with confidence: • Generate a research question and hypothesis or identify a research problem and potential solution • Develop a plan for investigation • Interpret and communicate the results • Evaluate the investigation	Students can, with confidence: • Work independently • Generate a research question and hypothesis or identify a research problem and potential solution • Conduct research • Consider the innovative aspects of their ideas and investigation • Develop a plan for investigation • Interpret and communicate the results • Critically evaluate the investigation	Students can, with confidence: • Generate a research question and hypothesis or identify a research problem and potential solution • Synthesise scientific ideas from research • Consider the innovative aspects of their ideas and investigation • Develop a plan for investigation • Interpret and communicate the results • Critically evaluate the investigation

Competitions and challenges

Once completed, **Intermediate** and **Advanced** CREST inquiries can also be submitted to your local Science Teachers' Association Awards.

Participation in these contests can be a very rewarding experience for your students and may lead onto other awards programs, including the national BHP Foundation Science and Engineering Awards, and the winners of this award may go on to compete at the Regeneron International Science and Engineering Fair!

*Please note – when submitting CREST inquiries into other contests, some states and/or territories only allow **2 students per group.** Please also ensure that students choose the appropriate category for their inquiry. Some categories may vary between State and Territory competitions.

• South Australia Science Teachers Association: Oliphant Science Awards
• Science Educators Association of the Australian Capital Territory: Science and Engineering Fair
• Science Teachers Association of New South Wales: Young Scientist Competition
• Science Teachers Association of the Northern Territory: Territory Young Scientist Competition
• Science Teachers Association of Queensland: Queensland Science Contest
• Science Teachers Association of Tasmania: Tasmanian Science Talent Search
• Science Teachers Association of Victoria Inc.: Science Talent Search
• Science Teachers Association of Western Australia: Science Talent Search

Contact CREST

You can contact the CREST team anytime by emailing crest@csiro.au or calling 1800 626 646.

Thank you for choosing to use CREST as a resource for your school and students. If you have any feedback or would like to share a story about your CREST journey, we would love to hear from you!