# iSTEM – PBL extension combined with mechatronics and robotics sample assessment package

**Practical task**



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## Advice to teachers

**Note:** the examples in this package are provided so that schools and teachers may choose relevant information and adjust for their contexts and their school-based practices. Relevant information should be transferred into the school’s assessment task template.

### Focus question

How accurately can we program a path for a robotic vehicle?

### Task

Students will work in groups to plan, develop, evaluate and iterate code for a robotic vehicle.

The task could be presented in different formats. The chosen mode for this task will be an electronic logbook, with defined sections and an accompanying video.

This task has been designed for robotic vehicles with limited autonomous capability. Teachers should adapt the task to assess the type of robotic vehicle created by students. If student robotic vehicles have autonomous driving capability, using sensors, then this should lead to changes in the criteria and advice for students.

### Task steps

Student groups should:

* define the problem
* create a path
* develop MicroPython code
* evaluate code against designated path
* iterate code based on observations
* document code iterations and reasoning
* video the final path of robot against the designated path
* communicate their process.

**Note:** the task steps provided in the Advice to students section are provided for use at teacher discretion. These can be used as a stimulus for students. They can also be used as a template for organisation during the task or as a template for the final logbook.

### Assessment type

This task is intended to directly contribute to the final course assessment, either formative when developing student skills and knowledge, or summative when determining student outcomes for this learning sequence.

Formative assessment is an active learning process that enables teachers to continuously gather evidence of learning and respond to student learning with the goal of improving student achievement (Cowie and Bell 2010). It is an interactive process that monitors student learning to provide ongoing feedback and can be used by teachers to improve their teaching and by students to improve their understanding. During the assessment task, teachers should continuously question student thought processes and decisions to elicit critical thinking and deeper understanding.

### Duration

Three lessons of class time are required to complete the practical assessment component. Assessment advice and due dates should be informed by school assessment policy and assessment schedules.

### Scheduling and weighting

This task is designed for Week 15 of the [iSTEM PBL extension combined with mechatronics and robotics learning sequence](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4). Consider this when creating your iSTEM scope and sequence. School reporting timelines may dictate when this learning sequence and assessment task is used.

Weightings are a school-based decision.

### Inclusion and wellbeing

This assessment package has been prepared by the NSW Department of Education. It has been developed as a model for teachers, to assist in the development of an assessment task that can be contextualised to an individual school’s needs.

The specific implementation of the assessment should reflect the school’s context, expertise of the teachers, and the prior knowledge and English language proficiency of the students.

Plan assessment tasks that are inclusive and accommodate the needs of all students in your classroom. Some students may require more specific adjustments and enhancements to allow them to participate on the same basis. The [iSTEM learning sequences](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4) have example adjustments and enhancements. For further advice, see [Inclusive practice resources for secondary school.](https://education.nsw.gov.au/campaigns/inclusive-practice-hub/secondary-school)

Outcomes referred to in this document are from the [iSTEM course document](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-course-document.docx) © NSW Department of Education for and on behalf of the Crown in the State of New South Wales (2021).

## Advice to students

### Task details

**Focus question:** How accurately can we program a path for a robotic vehicle?

**Type of task:** electronic logbook with accompanying video

**Format:** practical task

**Weighting:** school-based decision

**Submission:** students work collaboratively to complete and submit electronic logbook, including the video of the robotic vehicle.

**Outcomes assessed:**

* **ST5-2** demonstrates critical thinking, creativity, problem-solving, entrepreneurship and engineering design skills and decision-making techniques in a range of STEM contexts
* **ST5-3** applies engineering design processes to address real-world STEM-based problems
* **ST5-8** uses a range of techniques and technologies, to communicate design solutions and technical information for a range of audiences
* **ST5-9** collects, organises, and interprets data sets, using appropriate mathematical and statistical methods to inform and evaluate design decisions

### Task

Program your robotic vehicle to follow a specific path. The path must be a 2D triangle. The 3 separate points of the triangle must sit upon 3 different sides of a 1m2 square. Use masking tape to make this path on a flat surface. You can use predeveloped code you have created or library modules you have used in previous lessons to assist you in meeting the objectives of this challenge.

### Task steps

Use an electronic logbook to communicate the design process used to complete the challenge. The following steps must be included in your logbook.

#### Define the problem

Define the challenge to gain a better understanding of it. For example:

* mind map or brainstorm your initial thoughts
* define the success criteria based on the task instructions.

#### Identify the constraints

Outline specific boundaries that confine the challenge. For example:

* identify time available to complete the challenge
* identify available space, tools and equipment
* identify specific boundaries of the path.

#### Brainstorm solutions

Breakdown the challenge into smaller parts.

Create ideas for each part of the challenge and assign parts to group members.

#### Design

Design your path and complete initial measurements and calculations:

1. Use tape on a flat surface to construct a 1m2 square.
2. Use tape to construct a triangular path the robot will follow.
3. Draw a scale diagram of the path in your logbook, including measurements and angles.
4. Complete initial trials and calculations to show how long your motor will need to run for each straight section of path and to test motor instructions to accomplish turns by rotating in place (skid steer turn).

#### Prototype

Develop an initial path following code.

Use the Python development program previously used in class.

You may use predeveloped code you have created or library modules you have used in previous lessons.

#### Evaluate

Test your robot on the triangular path.

Create evaluation parameters based on the agreed success criteria from Define the problem. Record robot progress for detailed evaluation.

#### Iterate

Use evaluation results to adjust calculations and code that instructs the robot to follow the triangular path as closely as possible.

Test, evaluate and reiterate code until the robot follows the path.

Video record your robot’s final attempt at following the path. Include this recording in your electronic logbook.

## Marking rubric

**Note:** the criteria and outcomes presented in this table are not mandatory for assessing the task. Teachers are encouraged to select and/or adjust criteria based on their students’ needs and the assessment and reporting requirements of their school.

Table 1 – marking rubric

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Criteria | A | B | C | D | E |
| Define the problem, identify constraints, brainstorm solutionsST5-3 | Explicitly communicates synthesised, accurate and relevant constraints, success criteria, ideas and solutions about the challenge. | Communicates clear and accurate constraints, success criteria, ideas and possible solutions about the challenge. | Communicates constraints, success criteria, ideas and possible solutions about the challenge. | Defines part of the problem, identifies one constraint, records ideas for one part of the challenge. | Identifies a part of the problem. |
| Scale drawingST5-9 | Produces clear and accurate scale drawing of the vehicle’s path including scale key and all angles and distance measurements. | Produces an accurate scale drawing of the vehicle’s path including scale key and most angles or distance measurements. | Produces a drawing of the vehicle’s path including scale key, angles or distance measurements. | Produces a drawing of the vehicle’s path including angles or distance measurements. | Produces a drawing of the vehicle’s path. |
| CalculationsST5-9 | Effectively uses trials to inform calculations of time, distance and angle.Calculations accurately documented. | Uses trials to inform calculations of time, distance and angle. | Documents calculations of time, distance and angle. | Calculates motor operational time. | Uses motor timing for movement. |
| CodeST5-8 | Creates and uploads efficient code for straight line movement and turning (spin).Demonstrates desk-checking or other strategies to test logic of algorithms. | Creates and uploads functional code for straight line movement and turning (spin). Demonstrates desk-checking or other strategies to test logic of algorithms. | Uses and refines functional code for straight line movement and turning. | Uses code for straight line movement and turning. | Uses code for movement or turning. |
| EvaluateST5-2 | Documents the use of a systematic evaluation process and explains the significance of observations. | Documents the use of a criteria-based evaluation process. | Demonstrates use of an evaluation process. | Documents some trialling of robot and code. | Tests and uses code but no clear documentation of evaluation. |
| IterateST5-2 | Methodically demonstrates the use of evaluations to alter code by documenting code iterations.Clear and accurate use of notes to explain changes in code. | Demonstrates the use of evaluations to alter code by documenting code iterations.Clear use of notes to explain changes in code. | Demonstrates the use of evaluations to alter code by documenting code iterations and use of notes. | Documents different versions of code. | Uses different code to create different movement. |
| Communicates design solutionsST5-8 | Video demonstrates robot meeting all success criteria. | Video demonstrates robot meeting most success criteria. | Video demonstrates robot movement in a roughly triangular path and meeting some success criteria. | Video demonstrates robot movement in a roughly triangular path. | Video demonstrates robot movement. |

**Note:** a STEM skills student self-evaluation rubric can be found in the [critical problem-solving sample assessment package](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-assessment-package-critical-problem-solving.docx).

## Additional information

The information below can be used to support teachers when using this assessment package for iSTEM.

### Rationale

Australian businesses competing in a global economy will need more employees trained in science, technology, engineering, and mathematics (STEM). Research indicates that 75% of the fastest-growing occupations require STEM skills. Global accounting firm PwC (formerly known as PricewaterhouseCoopers) produced a report titled [‘A smart move’](https://www.pwc.com.au/publications/a-smart-move.html) where it found that shifting just 1% of the Australian workforce into STEM roles would add $57.4 billion to the Gross Domestic Product (GDP) (net present value over 20 years).

iSTEM is a student-centred Stage 5 elective course that delivers science, technology, engineering, and mathematics education in an interdisciplinary, innovative, and integrated fashion. It was developed in direct response to industry’s urgent demand for young people skilled in science, technology, engineering, and mathematics.

The course was developed in collaboration with, and is supported by, industry, business, government, and universities, ensuring that students develop future-focused STEM skills. The course has a number of specialised topics, many of which are aligned with NSW State Government priority industries, identified in the [NSW Industry Development Framework](https://www.investment.nsw.gov.au/living-working-and-business/nsw-industry-development-framework/).

iSTEM develops enabling skills and knowledge that increasingly underpin many professions and trades, and the skills of a technologically enabled workforce. It provides students with learning opportunities to develop knowledge and skills to use the most up-to-date technologies including additive manufacturing (3D printing), laser cutters, augmented and virtual reality, drones, smart robotics and automation systems, Artificial Intelligence (AI) and a range of digital systems.

Students gain and apply knowledge, deepen their understanding, and develop collaborative, creative and critical thinking skills within authentic, real-world contexts. The course uses inquiry, problem and project-based learning approaches to solve problems and produce practical solutions utilising engineering design processes.

iSTEM is aligned to the concept of ‘[Industry 4.0](https://www.weforum.org/agenda/2019/01/why-companies-should-strive-for-industry-4-0/)’ which refers to a new and emerging phase in the industrial revolution that heavily focuses on interconnectivity, automation, machine learning and real-time data.

iSTEM has been developed to meet the goals of National Federation Reform Council (NFRC) Education Council’s [National STEM School Education Strategy (2016-2026)](https://www.dese.gov.au/education-ministers-meeting/resources/national-stem-school-education-strategy), and supports the NSW Government’s [NSW Industry Development Framework](https://www.investment.nsw.gov.au/living-working-and-business/nsw-industry-development-framework/), the NSW Department of Education’s [Rural and Remote Education Strategy (2021-2024)](https://education.nsw.gov.au/about-us/strategies-and-reports/rural-and-remote-education-strategy-2021-24) and the [High Potential and Gifted Education policy](https://education.nsw.gov.au/policy-library/policies/pd-2004-0051).

### Aim

The aim of the course is to engage and encourage student interest and skills in STEM, appreciate the scope, impact and pathways into STEM careers, and learn how to work collaboratively, entrepreneurially, and innovatively to solve real-world problems.

### Purpose and audience

This assessment package provides a range of assessment strategies and supplementary material that can be used to support student achievement in the task outlined. This resource is for teachers when creating a program of assessment for the iSTEM course.

### When and how to use this document

Use the assessment package in the context that best supports your school context.

### Assessment for learning

Possible formative assessment strategies that could be included:

* Learning intentions and success criteria assist educators to articulate the purpose of a learning task to make judgements about the quality of student learning. These help students focus on the task or activity taking place and what they are learning and provide a framework for reflection and feedback. [Online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/622) can assist implementation of this formative assessment strategy.
* Eliciting evidence strategies allow teachers to determine the next steps in learning and assist teachers in evaluating the impact of teaching and learning activities. Strategies that may be added to a learning sequence to elicit evidence include all student response systems, [exit tickets](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/543), mini whiteboards (actual or [digital](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/575)), [hinge questions](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/557), [Kahoot](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/621), [Socrative](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/587), or quick quizzes to ensure that individual student progress can be monitored and the lesson sequence adjusted based on formative data collected.
* Feedback is designed to close the gap between current and desired performance by informing teacher and student behaviour (AITSL 2017). AITSL provides a [factsheet to support evidence-based feedback](https://www.aitsl.edu.au/teach/improve-practice/feedback#:~:text=FEEDBACK-,Factsheet,-A%20quick%20guide).
* [Peer feedback](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/549) is a structured process where students evaluate the work of their peers by providing valuable feedback in relation to learning intentions and success criteria. It can be supported by [online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=1d29b).
* Self-regulated learning opportunities assist students in taking ownership of their own learning. A variety of strategies can be employed and some examples include reflection tasks, [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645), [KWLH charts](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562), [learning portfolios](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/583) and [learning logs](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/583).

The primary role of assessment is to establish where individuals are in their learning so that teaching can be differentiated and further learning progress can be monitored over time.

Feedback that focuses on improving tasks, processes and student self-regulation is the most effective. Students engaging with feedback can take many forms including formal, informal, formative, summative, interactive, demonstrable, visual, written, verbal and non-verbal.

[What works best update 2020](https://education.nsw.gov.au/about-us/educational-data/cese/publications/research-reports/what-works-best-2020-update) (CESE 2020a)

### Differentiation

Differentiated learning can be enabled by differentiating the teaching approach to content, process, product and the learning environment. For more information on differentiation go to [Differentiating learning](https://education.nsw.gov.au/teaching-and-learning/professional-learning/teacher-quality-and-accreditation/strong-start-great-teachers/refining-practice/differentiating-learning) and [Differentiation](https://education.nsw.gov.au/campaigns/inclusive-practice-hub/primary-school/teaching-strategies/differentiation).

When using these resources in the classroom, it is important for teachers to consider the needs of all students in their class, including:

* **Aboriginal and Torres Strait Islander students**. Targeted [strategies](https://education.nsw.gov.au/teaching-and-learning/aec/aboriginal-education-in-nsw-public-schools) can be used to achieve outcomes for Aboriginal students in K-12 and increase knowledge and understanding of Aboriginal histories and cultures. Teachers should utilise students’ Personalised Learning Pathways to support individual student needs and goals.
* **EAL/D learners**. EAL/D learners will require explicit English language support and scaffolding, informed by the [EAL/D enhanced teaching and learning cycle](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald/enhanced-teaching-and-learning-cycle) and the student’s phase on the [EAL/D Learning Progression](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency). In addition, teachers can access information about [supporting EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency) and [literacy and numeracy support specific to EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald).
* **Students with additional learning needs**. Learning adjustments enable students with disability and additional learning and support needs to access syllabus outcomes and content on the same basis as their peers. Teachers can use a range of [adjustments](https://education.nsw.gov.au/teaching-and-learning/disability-learning-and-support/personalised-support-for-learning/adjustments-to-teaching-and-learning) to ensure a personalised approach to student learning. In addition, [Curriculum planning for every student in every classroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12) can be used to support the diverse learning needs of students using inclusive teaching and learning strategies. Subject specific curriculum considerations can be found on the [Inclusive Practice hub](https://education.nsw.gov.au/campaigns/inclusive-practice-hub).
* **High potential and gifted learners**. [Assessing and identifying high potential and gifted learners](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/assess-and-identify#Assessment1) will help teachers decide which students may benefit from extension and additional challenge. [Effective strategies and contributors to achievement](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/evaluate) for high potential and gifted learners help teachers to identify and target areas for growth and improvement. In addition, the [Differentiation Adjustment Tool](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/implement/differentiation-adjustment-strategies) can be used to support the specific learning needs of high potential and gifted students. The [High Potential and Gifted Education Professional Learning and Resource Hub](https://schoolsnsw.sharepoint.com/sites/HPGEHub/SitePages/Home.aspx) supports school leaders and teachers to effectively implement the High Potential and Gifted Education Policy in their unique contexts.

All students need to be challenged and engaged to develop their potential fully. A culture of high expectations needs to be supported by strategies that both challenge and support student learning needs, such as through appropriate curriculum differentiation (CESE 2020a:6).

### About this resource

All curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice contact the Teaching and Learning Curriculum team by emailing secondaryteachingandlearning@det.nsw.edu.au.

**Alignment to system priorities and/or needs**:

This resource aligns to the School Excellence Framework elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

This resource supports teachers to address [Australian Professional Standards for Teachers](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 5.1.2, 5.5.2.

This resource has been designed to support schools with successful implementation of new curriculum, specifically the NSW Department of Education approved elective course, iSTEM © 2021 NSW Department of Education for and on behalf of the Crown in right of the State of New South Wales.

The resource is produced to assist schools with promoting and implementing the course for the first time. As the course may be taught by teachers from a range of key learning areas, the resource is designed to support teachers from a variety of KLA expertise.

**Department approved elective course**: iSTEM

**Course outcomes**: ST5-2, ST5-3, ST5-8, ST5-9

**Author**: Curriculum Secondary Learners

**Publisher**: State of NSW, Department of Education

**Resource**: Assessment resource

**Related resources**: Further resources to support iSTEM can be found on the Department approved elective courses webpage including course document, sample scope and sequences, assessment materials and other learning sequences.

**Professional Learning**: Join the [Teaching and Learning 7-12 statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms) for information regarding professional learning opportunities.

**Consulted with**: Aboriginal Outcomes and Partnerships, Inclusion and Wellbeing, and EAL/D. Staff from Willyama High School.

**Reviewed by**: This resource was reviewed by Curriculum Secondary Learners and by subject matter experts in schools to ensure accuracy of content.

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**Evidence base**

The range of assessment strategies outlined in the advice encourages ‘a variety of assessment methods each lesson to check for students’ understanding and inform what should be taught next’. (CESE 2020a:22). The assessment strategies outlined are student-centred, providing ‘students with opportunities to reflect on their progress to inform future learning goals’ (CESE 2020a:22).

The assessment strategies outlined provide teachers with important information about whether students learned what was intended. Wiliam (2013) claims ‘the term formative should apply not to the assessment but to the function that the evidence generated by the assessment actually serves’.

## References

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