The All Terrain Challenge – An Interdisciplinary Rich Task linking Design Technology, Mathematics and Science

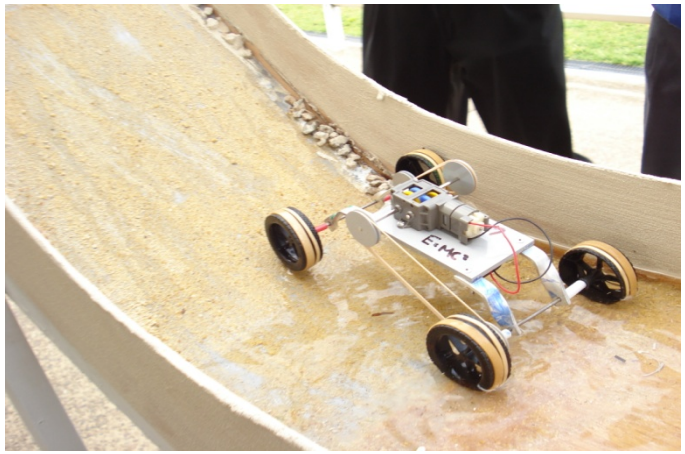
Terry Byers
Head of Faculty – Middle School Mathematics

What is the All Terrain Challenge (ATC)?

- Interdisciplinary unit across Design Technology, Mathematics and Science.
- Year 7 students, in small groups, assume the role of real-world professionals to design, construct, test and modify an electric powered vehicle.
- Students learning is enriched by tertiary academics and students from the Queensland University of Technology's Motorsport program.

What is the All Terrain Challenge (ATC)?

- A series of interconnected hands-on learning experiences in Mathematics and Science.
- These learning experiences feed directly into the design, construction and appraisal of an ATC vehicle in Design Technology.
- A culminating ‘Showcase Day’ allow groups to test their vehicles on the test track and have real-world experts (from the QUT motorsport program) judge their vehicles.

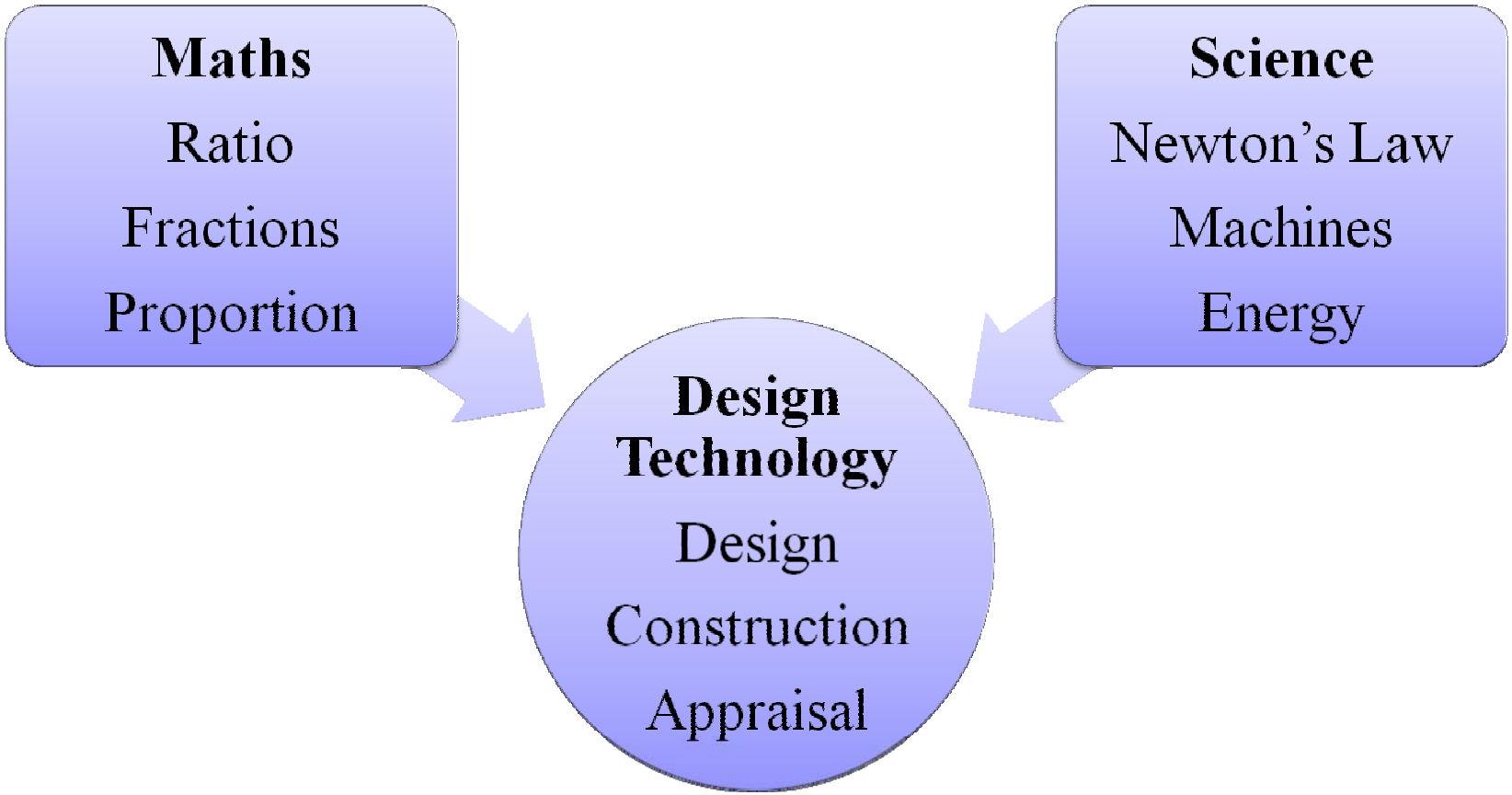


Goals of the All Terrain Challenge

The ATC was seen as an opportunity to achieve two significant goals.

- The first was to engage students in rigorous learning that encourages the integration of knowledge and skills from different subject disciplines in a real-world context, which extends and challenges them beyond the classroom.
- The second, is the use of authentic assessment to drive pedagogical and curriculum reform by ‘building the capacity’ of teachers. i.e. improving their threshold knowledge, practices and confidence.

Big Ideas Flowchart



Barriers to Success

- Overcoming the traditional “subject divide”
- Boys from the same form class in different Mathematics, Science and Design Technology classes to their peers.
- Lack of collaborative planning and preparation time.
- The same subject occurring at different times in the timetable.
- Teachers who have not seen the “end product”.

Key Factors to Success

- 3 Faculties prepared to share ideas, workload and materials.
- Heads of Faculty and Teachers who were prepared to try ‘new things’ and approaches.
- Linkage with the Queensland University of Technology, allowed the boys access to real-world experts.

ATC – Collaborative Unit Plan

- To overcome the existing barriers, the 3 Faculties devised a unit plan around the "Big Ideas" and the main objectives of:
  - Connections between the classroom and the real-world.
  - Nurture problem-solving and higher-order thinking.
- Synthesised from the QCAR and "Rich Task" planning templates.

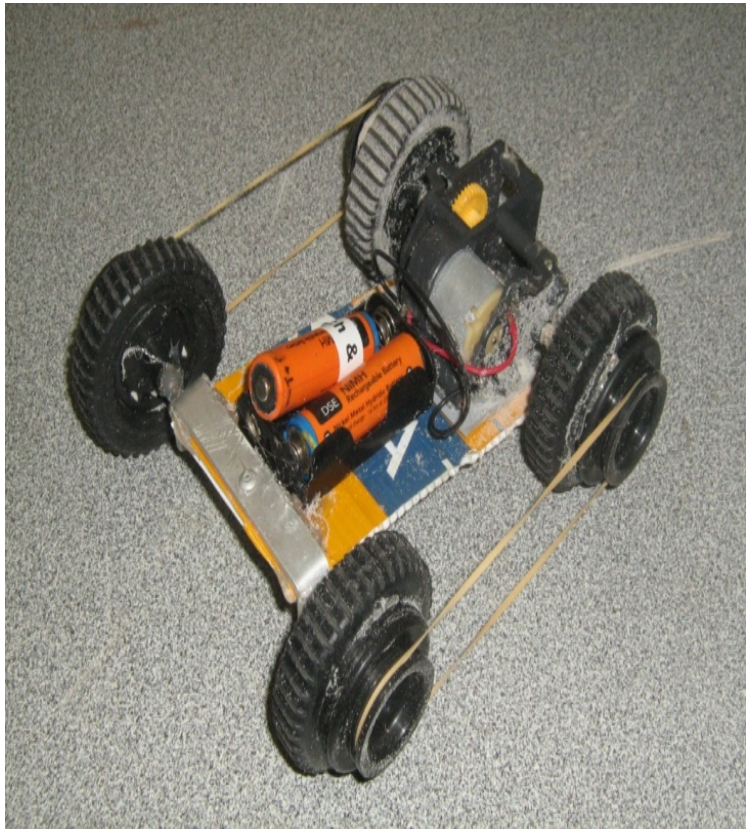
ATC - Unit Overview

Culminating Activity - Showcase Day

- Allowed the boys the opportunity to test their vehicles against their peers on the test track.
- The vehicles had to contend with 4 different terrains.
- Vehicles design and construction was appraised by the QUT Motorsport students.

Science

- In this exercise the students need to have success.
- Their *All Terrain Vehicle* has to move through and over the track.

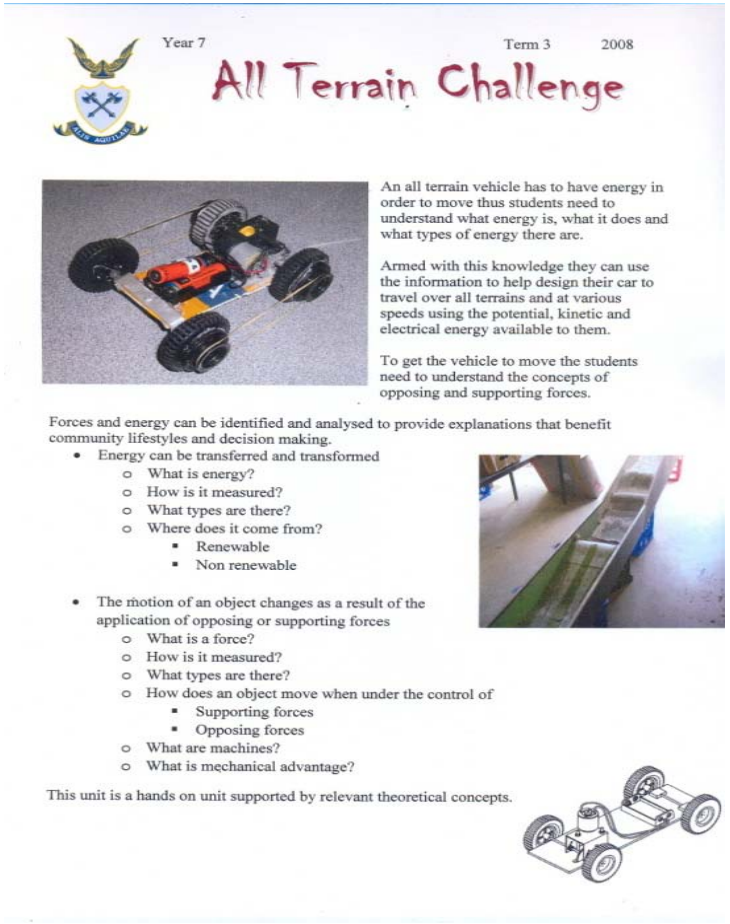


Science – The Big Ideas

- Energy can be transferred and transformed
  - What is energy?
  - How is energy measured?
  - What types of energy are there?
  - Where does energy come from?
    - Renewable
    - Non renewable
- The motion of an object changes as a result of the application of opposing or supporting forces
  - What is a force?
  - How is it measured?
  - What types are there?
  - How does an object move when under the control of
    - Supporting forces
    - Opposing forces
  - What are machines?
  - What is mechanical advantage?

Science – Resources

- Resource Booklet
- Practical activities investigating
  - Forces
    - Friction
    - Gravity
    - Forces in water
  - Machines
    - Types
    - Mechanical Advantage



Year 7 Term 3 2008

All Terrain Challenge

An all terrain vehicle has to have energy in order to move thus students need to understand what energy is, what it does and what types of energy there are.

Armed with this knowledge they can use the information to help design their car to travel over all terrains and at various speeds using the potential, kinetic and electrical energy available to them.

To get the vehicle to move the students need to understand the concepts of opposing and supporting forces.

Forces and energy can be identified and analysed to provide explanations that benefit community lifestyles and decision making.

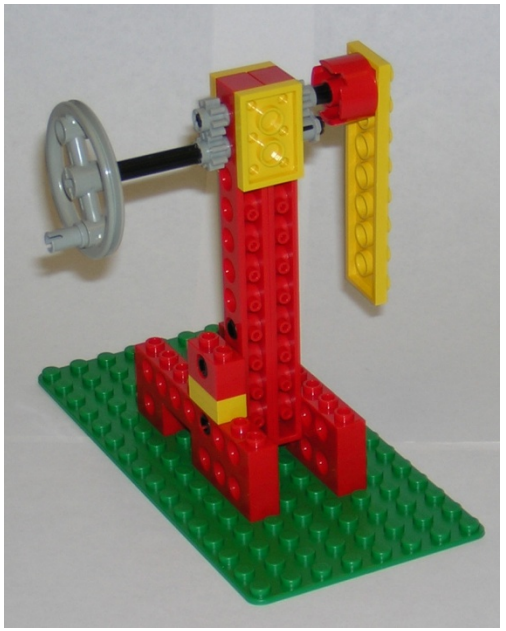
- Energy can be transferred and transformed
  - What is energy?
  - How is it measured?
  - What types are there?
  - Where does it come from?
    - Renewable
    - Non renewable
- The motion of an object changes as a result of the application of opposing or supporting forces
  - What is a force?
  - How is it measured?
  - What types are there?
  - How does an object move when under the control of
    - Supporting forces
    - Opposing forces
  - What are machines?
  - What is mechanical advantage?

This unit is a hands on unit supported by relevant theoretical concepts.

Mathematics – The Big Ideas

The ‘Big Ideas’ for mathematics were:

- Fractions
- Ratio
- Proportionate Reasoning
- Rates



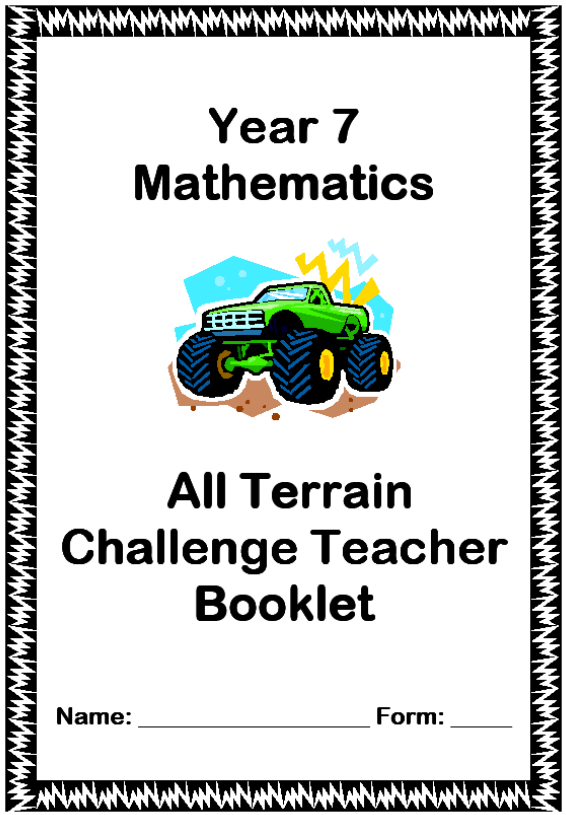
Mathematics – Resources

- Teacher and Student Resource Booklet
- Interactive Manipulatives

  Ratio Stadium

  Free Ride
- Problem-based Investigations supported by hands-on resources (Lego)

  Investigation - Gears Lab



Design Technology

Design Technology

- Making real world connections through QUT Motorsport program
- Using the knowledge from the other subject disciplines
- Linking middle school classroom activities to senior school Engineering Technology subject then on to Engineering tertiary studies

Design Technology

- Making real world connections through QUT Motorsport program

  - How an all terrain vehicle works in a real world situation eg. Driving on the beach

  - Designing the All Terrain Challenge around a real world engineering problem, not just a construction project.

Design Technology

- Using the knowledge from the other subject disciplines
  - Science, Friction
  - Maths, Gear Ratios
  - Also within the Design & Technology subject area.

Design Technology

- Linking middle school classroom activities to senior school Engineering Technology subject then on to Engineering tertiary studies

  - Constantly guiding students to the engineering technology subject area

  - use of terminology and structure.

Design Technology

- Teacher and Student Resource Booklet

  Title Page

- Research based Investigations supported by hands-on demonstrations, activities and testing

  Research Document

- ATV and Vehicle kit

Design Technology

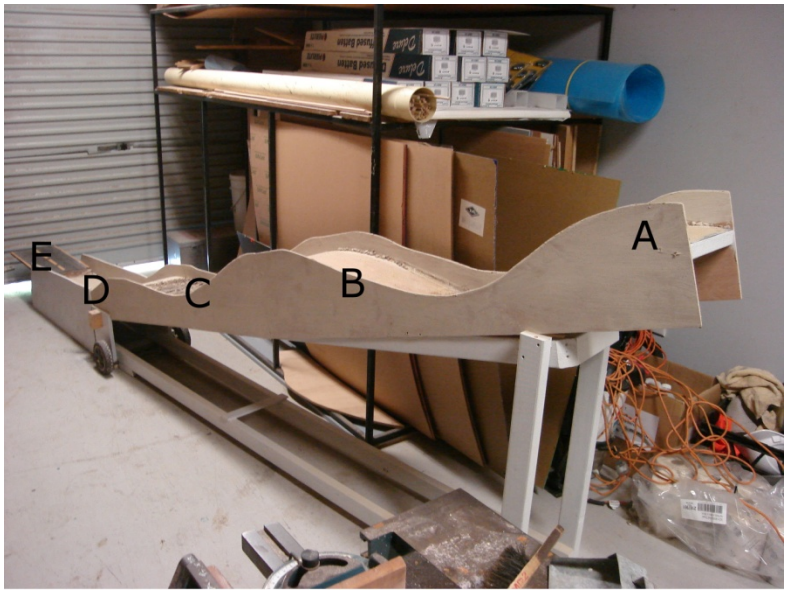
- Track analysis and lesson focus

  - Broken up into sections A, B, C, D, E

  - Focus on a section for the lesson eg (A) water section, what is needed?

- 40 groups, 3 students per Group

- Challenging but achievable engineering problem



A	B	C	D	E
5	24	11	0	0

Design Technology

- Track sectional analysis, Section E
- Lesson focus, Propulsion Systems

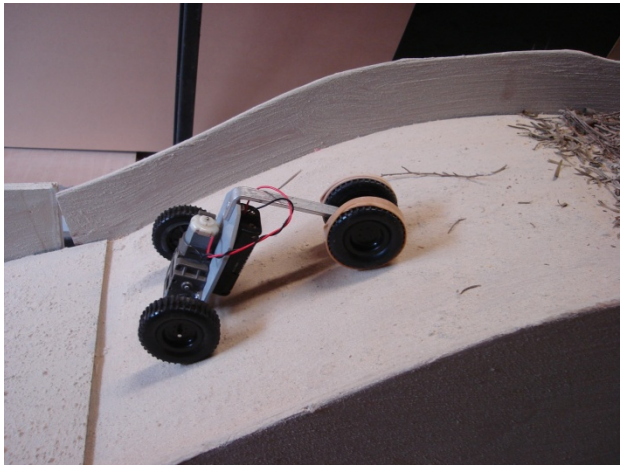
  Propulsion Systems
- Flat road ensures success

Design Technology

- Track sectional analysis, Section D
- Lesson focus

  - Tyre Width & Tread Tyre Width and Tread

  - Gear Box Ratio (link to Maths) TAMIYA Gear Box
- First challenge for the Vehicles to overcome.

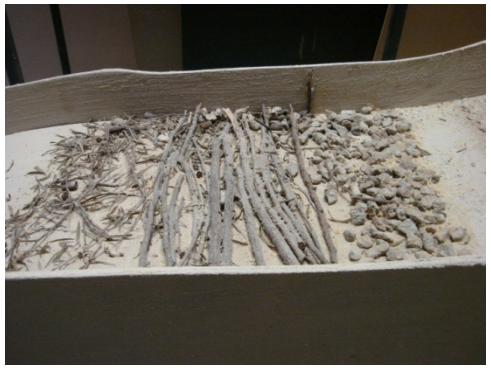


Design Technology

- Track sectional analysis, Section C
- Lesson focus

  - Ride Height Ride Height

  - Ground Clearance
- Logs and rocks section, demonstrates sound knowledge and understanding of content covered.



Design Technology

- Track sectional analysis, Section B
- Lesson focus

  - 2 Wheel Drive vs. 4 Wheel Drive

    2 Wheel drive vs. 4 Wheel Drive

  - Centre of Gravity (link to knowledge learnt from science)

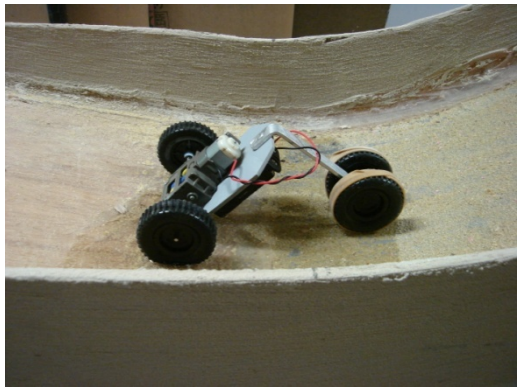
- Hill section, demonstrates knowledge and understanding of content covered.

Design Technology

- Track sectional analysis, Section A
- Lesson focus

  - Electronics Electronics

  - Surface friction (Linked to Science)
- Water section & final hill, demonstrates excellent knowledge and understanding of content covered.



Design Technology

- Design Analysis

  - Design proposal to solve real world engineering problems explaining the situation, need and brief

  Design Proposal

  - Brainstorming, Concept Sketches and Final Design drawing from the knowledge learnt through the student resource booklet, research based Investigations, hands-on demonstrations & activities

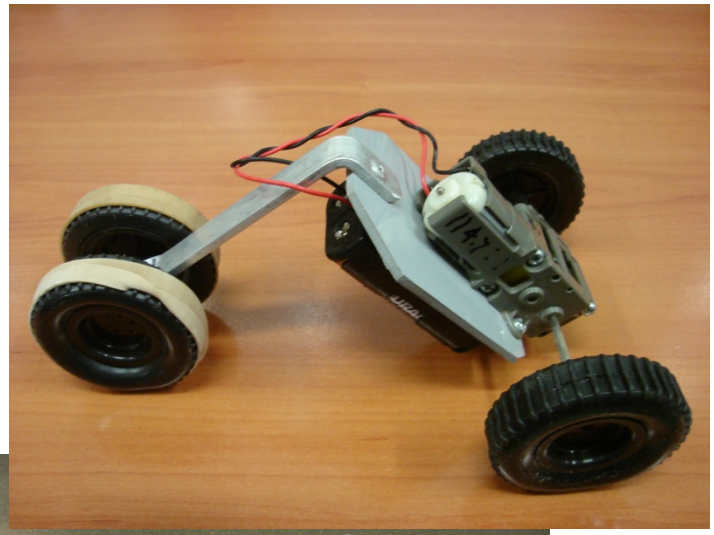
  Brain Storming Final Design

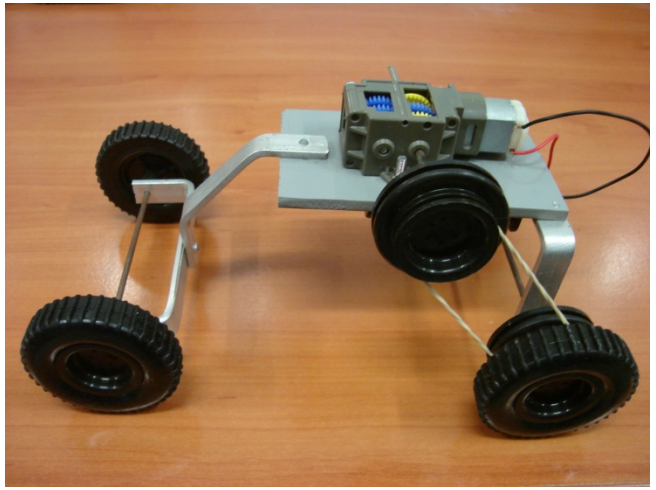
  - Construction Procedure, evaluation, testing and re-evaluation.

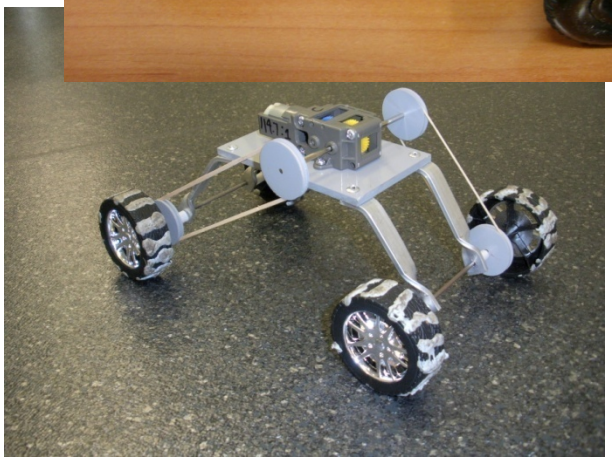
  Design Evaluation

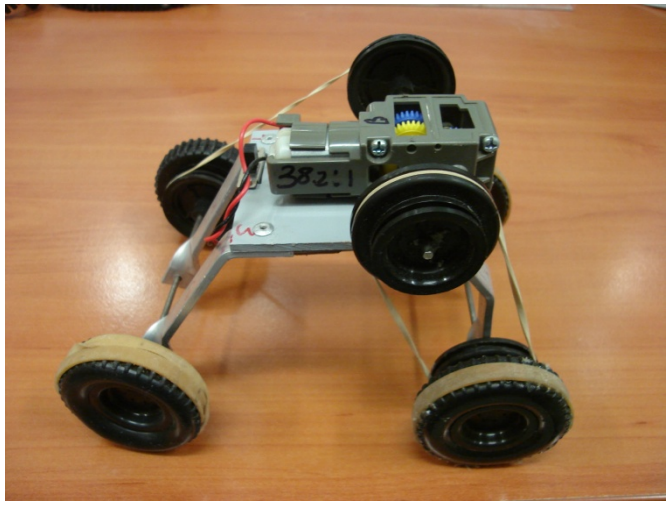
Design Technology

- ATC Vehicles









Student Surveys

- A 22-item Likert-scale pre-tested student survey was designed for the quantitative component of the study.
- The questions were based on the Ng and Stillman's (2007) study of the effect of interdisciplinary learning across the affective domains of student learning in mathematics.
- The survey consisted of four sections relating to the effect that the ATC had on students' general and subject-specific attitudes, confidence and ability.

Student Survey Item

Surveys – Levels of Enjoyment

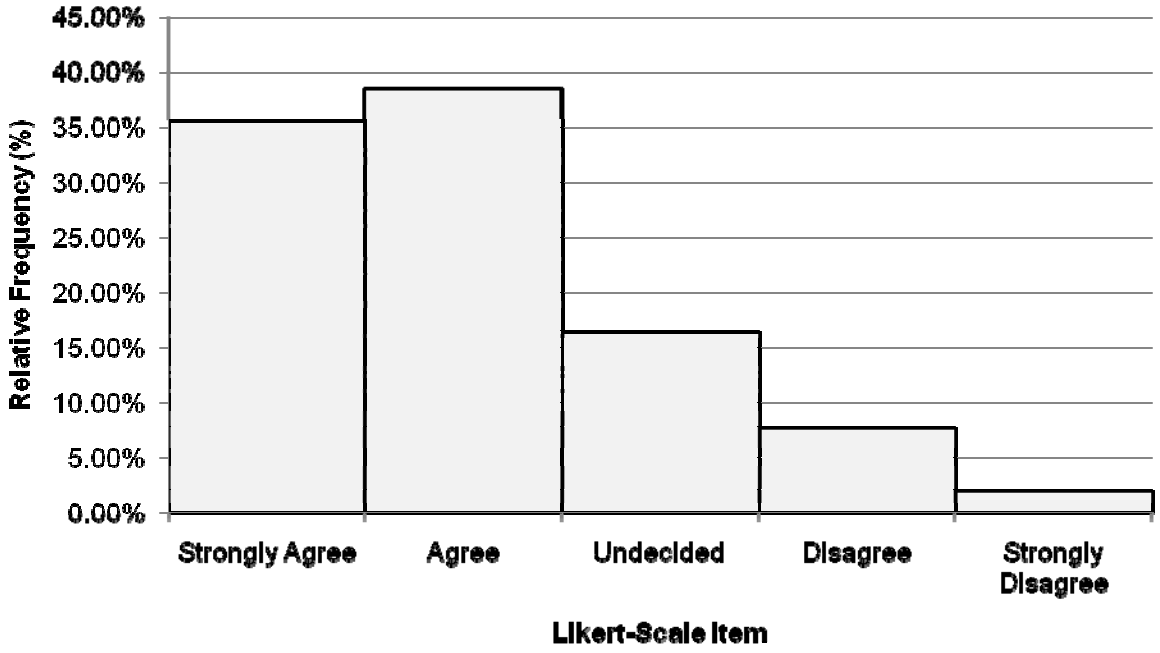


Figure 1: Improvement in Student Enjoyment Levels caused by involvement in the All Terrain Challenge

Surveys – Student Attitudes

Student Attitude	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Motivating	28.85%	35.58%	25.00%	8.65%	1.92%
Challenging	41.35%	42.31%	9.62%	5.77%	0.96%
Interesting	33.65%	47.12%	13.46%	4.81%	0.96%
Difficult	22.12%	53.85%	14.42%	5.77%	3.85%

Table 1: Influence of the All Terrain Challenge on Students' Attitudes in General