Teaching Robotics to stem the decline of STEM

Presenter: Mark Lockett

Monday, July 9, 2:00 PM
I always wanted to be an Engineer
Honours Degrees in Electronic Engineering
Engineer intern for a couple of summers
Post Grad in Education in Design Technology
Taught for 2 years in the UK
Taught Robotics, Engineering and Design at TSS for 22 years
STEM enrolments hit 20-year low
Australian Government Report

**STEM in Australia**
Decline in University students choosing STEM courses from 30% in 2000 to **18%** in 2015.

**STEM in China**
In 2015, **47%** of University Students.

**STEM in Singapore**
In 2015, **35%** of University students.

**Australian Bureau of Statistics**
STEM-related jobs in Australia will increase by **13%**.
STEM in Australia

Reasons: (National surveys)

Lack of interest in STEM subject at school.
Lack of information regarding STEM careers.
How do we combat a lack of interest?
Excuse me Miss,
Why do I need teachers when I have Google?
.... another student answered, saying that she was going to university to study History because her teacher had not taught her everything about history BUT she taught her the love of history.

How do we create a ‘Love of STEM’?
Single Loop Learning/Teaching
V’s
Double Loop Learning/Teaching
Single Loop Learning

Mental Model of what we should do.

Action or Process

Outcome

→

→

←

←
Using the Single Loop Learning Approach

Problem: Car in the Harbour.  SLL Solution: Get a Crane.
Outcome: Car and Crane in the Harbour
SLL Solution: Get a Crane
Outcome: 2 Cranes in the Harbour
SLL Solution : Get a Crane.
Single Loop Learning/Teaching
How we teach STEM

Mental Model of how we should teach STEM (often set at University or by the curriculum)

Action or Process of Teaching STEM

Outcomes of Teaching STEM

Sage on the Stage (Instructor Model)
STEM and the Instructor Mental Model
Double Loop Learning/Teaching

Mental Model of how we should teach STEM

Guide on the Side (Facilitator)

Action or Process of Teaching

Sage on the Stage (Instructor)

Outcomes of Teaching
Testing Gear Ratios V’s Generator Output
STEM and the Facilitator Mental Model
What has been the impact of using a Double Loop Learning approach at TSS?
Percentage of TSS Year 12s accepting a STEM courses at University

- 30% National Average in 2000
- 14% Boom in the Housing Market
- 18% National Average in 2015
- 30%
Engaging TSS Students in STEM courses

- Science – Inquiry Based Learning.
- Technology – CAD, CAM, 3D, VR, Game Design.
- Engineering – Robotics and Drones.
- Maths – Real World Problems.
Why Robotics?
Teaching STEM through Robotics

Mathematics
- Trigonometry
- Geometry
- Percentage Error
- Maths for PID control
- Data Functions

Science
- Dynamics
- Statics
- Datalogging and Sensors
- Autonomous Testing Rigs
- Scientific Method

Engineering
- Systems
- Coding
- P.I.Ds
- Image Processing
- Electronics
- Design
- Boolean Logic

Technology
- Electronics
- Mechanics
- Structures
- Pneumatics
- Hydraulics
How do boys learn best?

• ‘Hands-on, Minds-on’ approach.
• Project based assessment.
• Small groups.
• Movement in the classroom.
• Competitions.
• Real world application.
• Creativity.
• Support failure and redesign iterations.
What is ‘Hands-on, Minds-on’?
The Somatosensory Cortex
What does it do?

Proprioception detect the position of the body in space.
Nociception detect pain.

Links the sensory and motor systems and the cerebral cortex.
The Somatosensory Cortex
Representation of our body found within our brain.

SENSORIAL

MOTOR
Let’s try a Hands On, Minds On Activity
Tricks to building with LEGO

• Don’t have a meeting with yourself about what you are going to build.
• Don’t look at what others are doing.
• Just start putting blocks together.
• Let your brain ‘catch up’ to your hands.
Open the bag and place the six bricks in front of you.
Using the bricks, build a duck
Show Time!

Create a duck pond collection with your colleagues

OR

Hold up your duck and look around the room at the other ducks.

What do you notice about the ducks in the room?
The Power of Imagination
What are the skills being used?

- Emotional regulation
- Long term memory
- Mental imagery
- Systems thinking
- Visual perception
- Imitation
- Adaptive social functioning
- Perspective taking
- Self assessment
- Problem solving
- Creativity
- Decision making
- Self efficacy
- Visual search
- Kinaesthetic awareness
- Spatial visualisation
- Sensory motor skills
- Mental rotation
- Working memory
- Fine motor skills
- Short term memory
- Cognitive flexibility

6 LEGO® bricks...

21 skills are used...
Future Job Skills

Top 10 skills by 2020
World Economic Forum

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgement and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

Google’s top skills

1. Being a good coach
2. Communicating and listening well
3. Possessing insights into others
4. Having empathy
5. Being a critical thinker and problem solver
6. Making connections across complex ideas
... ...
X. STEM Expertise
The Southport School
Robotics and Engineering Program
Open ended learning!
Year 7 and 8
Working in Pairs – Basic Hardware
The Spares Cupboard
Unsorted Boxes

Adapt ideas to suit the available parts
Sports 2025:
How Technology Will Change How We Fan, Follow and Play Sports in the Future
Feedback
Yr. 8 Robotics – Hill Climb
Hill Climb
Year 8 Robotics
Disk Collector

Build and program a Robot to knock out 10 disks from a circular arena. The robot must comply with width and length restrictions.

Your grade will be determined by how fast the disks are knocked out the arena. A disk is classes as being knock out if over half of it is on the black line.

The robot must start with all parts of the robot within the black line of the arena.
# Grading and Limitations

## Disk Collector Scoring Times

<table>
<thead>
<tr>
<th>Grade</th>
<th>Time</th>
<th>Emoticon</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>14 seconds or less</td>
<td>😊</td>
</tr>
<tr>
<td>A</td>
<td>16 seconds</td>
<td></td>
</tr>
<tr>
<td>A-</td>
<td>18 seconds</td>
<td></td>
</tr>
<tr>
<td>B+</td>
<td>22 seconds</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>26 seconds</td>
<td></td>
</tr>
<tr>
<td>B-</td>
<td>28 seconds</td>
<td>😞</td>
</tr>
<tr>
<td>C+</td>
<td>33 seconds</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>38 seconds</td>
<td></td>
</tr>
<tr>
<td>C-</td>
<td>43 seconds</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Goes forward but does not see black</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Does nothing.</td>
<td>😞</td>
</tr>
</tbody>
</table>

## Year 8 Disk Collector sizes

- **Width Size**
- **Length Size**
Feedback
Swift Playgrounds Drone Course
takeOff()
mov(direction: MoveDirection.up, duration: 2)
wait(2)
flip(direction: FlipDirection.front)
wait(2)
mov(direction: MoveDirection.forward, duration: UInt(3))
wait(2)
turn(direction: TurnDirection.right, angle: UInt(90))
mov(direction: MoveDirection.forward, duration: 1)
wait(2)
land()
Year 9 Robotics
Robotic Engineering

Start of Lesson

Build and Test

End of Lesson

Adaptability
Mars Mission
Out takes!
#pragma config(Sensor, dgtl6, touchSensor, sensorTouch)
#pragma config(Motor, port2, rightMotor, tmotorNormal, openLoop, reversed)
#pragma config(Motor, port3, leftMotor, tmotorNormal, openLoop)

//+++++++++++++++++++++++++++++++++++++++++++++++++++++++| MAIN ++++++++++++++++++++++++++++++++++++++++++++++++++++++++
task main()
{
    wait1Msec(2000); // Robot waits for 2000 milliseconds before executing program

    while(SensorValue(touchSensor) == 0) // Loop while robot's bumper/touch sensor isn't pressed in
    {
        motor[rightMotor] = 63; // Motor on port2 is run at half (63) power forward
        motor[leftMotor] = 63; // Motor on port3 is run at half (63) power forward
    }
} //+++++++++++++++++++++++++++++++++++++++++++++++++++++++
Autonomous Mode
Driver Control Mode
Yr 10, 11 and 12 Senior Engineering
Drone Pilot Licence
Young Engineers’ Society/Makerspace
Robotics Competitions
International FIRST Competition
Gains in STEM Interest through Robotics Competitions

OVER 75% of FIRST Alumni are in a STEM FIELD AS A STUDENT OR PROFESSIONAL

THEY ARE OVER 2X as likely to show gains in their interest of STEM (than a matched comparison group of students)
Tell me, and I will forget. 
Show me, and I may remember. 
Involve me, and I will understand. 
- Confucius, 450 B.C.

The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge.

(Seymour Papert)
Times are a changing ..
Future STEM classrooms
Contact Details

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You can keep your ducks 😊
Thank you for listening.