FOCUS:

To investigate the use of Labview software in ROBOLAB to build programmes of work for students in Y6- Y8 and research educational outcomes from the use of this programme

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Report on Sabbatical Leave Project July/August 2005

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This report is in two parts:

The first part gives and a summary of the Robolab conference in Austin, Texas in August 2005 and general information about the robotics programme.

The second part shows a programme that could be used, adapted or modified if someone was thinking about using robotics. It contains lesson plans and links to curriculum skills, science, technology and maths objectives and useful web links. As far a is possible I have tried to also link these to the new draft curriculum statement as of September 2005.

Conference Report Summary of International ROBOLAB Conference

The ROBOLAB Conference is:

- A forum for ROBOLAB enthusiasts and master teachers to share what they are doing
- An opportunity to learn the more advanced capabilities of LEGO Mindstorms and support from other ROBOLAB users
- A chance to see what's in the future of ROBOLAB and LEGO Education
- An occasion to meet other ROBOLAB/robotic enthusiasts and share ideas.

A key goal of this conference is to enlarge the present ROBOLAB community. There are workshops for users of all abilities, from the novice to the expert. Workshop topics range from "Getting Started with ROBOLAB" to "Image Processing".

Presentation from educators, both formal and informal, and others that have used ROBOLAB will be featured.

Members of the planning committee will moderate discussion in their area of expertise to help users explore the practical applications of ROBOLAB.

For me the goals of the conference were effectively delivered and gave me insight in

(1) Seeing the big picture.

The robotics conference was part of a much larger conference run by National Instruments. In the exhibition hall, showing their latest developments were engineers from a wide range of industries, including automotive, aerospace, biomedical, electronics, government/defense, and universities. Their machines were using labview software.
At the robolab presentations there were a range of ideas and developments presented, both in teaching and learning and with innovative ideas and applications of the labview software and the RCX brick. They ranged from using robotics with a special needs class through to university engineering applications.

(2) Improving my own knowledge and skills

It was good to listen to the presentations to hear what other people were doing, their enthusiasm for their projects, how they set up their classes, what their aims were and how their groups of children responded.
The workshops were taken by engineers from Tufts university, they were enthusiastic in developing and growing their outreach programme and shared their knowledge and skills freely.
Talking to other educators as we worked on tasks together was helpful as we could share the detail about what we were doing, how we overcame problems, what worked well etc.

(3) Knowing about the ongoing research and development especially at Tufts university with particular reference to K-12 programmes of work for children.

(4) Networking with other educators and establishing contact with other robolab users

(5) Giving guidance for the next steps I wanted to take in finding good material to format a teaching programme

Where to now - My Future Goals

- Share information with other principals at Central Otago Principals conference in November 2005
- Set up workshop for interested educators and groups of children in February 2006
- Introduce engineering component into St Gerard's school programme for Y4-Y8, 2006
- Continue, with revised format, Robolab programme for Y7-Y8
- Introduce after-school workshops in Terms 2 and 3 2006 for pupils interested in Robocup competition
- Have at least one team performing in at least one category in the Robocup competition in Christchurch, August 2006.

Research and reflection

About robotics

What is a robot?
1. an automated machine that is made to work like a human being
2. an automatic mechanical device for performing a certain job again and again (NASA)
A robot is a machine that gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts) (National Instruments)

A robotics programme for schools
The robotics programme discussed in this report uses technic lego and a programme called labview. Labview is used in industry and is the programme used by NASA for the Mars Rover. There are other programmes for robotics available but I have used this one because it is user friendly for someone with no background in engineering, it is adaptable for all stages of learning, and with the lego component things work (ie. gears mesh, motors are robust).

Quote from Lego http://www.lego.com/eng/education/mindstorms/default.asp

LEGO MINDSTORMS for Schools is a classroom solution from LEGO Educational Division that integrates robotics and programming. It is the ideal hands-on tool for helping your students learn a variety if topics including math and science, and computer and design technology.

Taking direction from the student worksheets, students set about solving problems. They construct a robot to perform specific duties and then write a program for the robot using the ROBOLAB software. After downloading the program from the computer to the RCX, LEGO programmable brick, via infrared, students observe if their solution was successful. They then have the opportunity to modify or optimize their solution.

Quote from National Instruments
LabVIEW is a graphical programming language from National instruments, used primarily in Data Acquisition and Instrumentation control.

With the shared goal of motivating students to develop engineering intuition, National Instruments, LEGO Dacta, and Tufts University formed a partnership to create an exciting educational program called ROBOLAB.
"We are proud to partner with LEGO Dacta and Tufts to help develop the engineers and scientists of tomorrow," said James Truchard, President and CEO of National Instruments. "ROBOLAB gives students hands-on experience with engineering concepts in a fun and innovative way."
ROBOLAB uses a powerful combination of LEGO bricks and National Instruments LabVIEW graphical development software to introduce engineering concepts to students of all ages - from kindergarten through high school.
The ROBOLAB software, jointly developed by National Instruments, Tufts University, and LEGO Dacta, is engineered for the classroom and teaches basic computer programming, robotics, and automation skills.
"We chose National Instruments LabVIEW for our ROBOLAB system because it is easy to teach students fundamental programming skills with the LabVIEW graphical programming language," said Chris Rogers, Associate Professor of Mechanical Engineering at Tufts. "LabVIEW is a standard tool for engineers and scientists in the work force, yet its simple graphical interface kids as young as kindergartners can use it with ease."
http://www.ni.com/company/robolab.htm

Why this product?
For a general classroom teacher like me with no engineering or computer programming skills this was a straightforward useable product with which pupils could use successfully with minimum teacher background knowledge.
As technology becomes increasingly important in the global community, there is an ever-growing need for technological literacy amongst the population. Integrating engineering with education on the K-12 level will foster the development of students' technological literacy; a valuable skill in becoming a global citizen.

From-The Benefit of Outreach to Engineering Students
Authors: Melissa Pickering, Emily Ryan, Kaitlyn Conroy,
Brian Gravel, Merredith Portsmore Affiliation: Tufts University

Research and Reports
Go to
http://www.lego.com/education/default.asp?page=2_5

Also reports from the Austin conferences 2004 and 2005
http://www.ceeo.tufts.edu/services/conferences/robolabconference/
and ongoing research at Tufts
http://www.tuftl.tufts.edu/research/educationresearch.shtm

Who benefits from the programme ?
I use this with Y7 and Y8's because this is the area I teach. It can be successfully used at Y5 and Y6 and some people report using it at younger

age groups. At the recent International conference in Texas a paper was presented showing how this can be used with a special needs class.

Any prerequisites?
Pupils can go straight into the programme without any prior knowledge. However I feel that a good introduction to robotics is the experimentation with a lego kit such as simple and powered mechanisms, mechanical engineering or renewable energy.
Besides being useful practical resources for science and technology they give pupils good experience in understanding how to fit components together, making sound models, understanding engineering problems and creating workable solutions. When they come to robotics from this background they can make models quickly and concentrate on the programming aspects and possibilities. I still use a variety of these kits side-by-side with the robotics programme at Y7 and 8 and find there is still plenty of challenge and good learning opportunities with them.

I have found all children in the class benefit from the programme, not just those who show initial interest. Certainly, as in all subjects, some children have a special enthusiasm for this work, others enjoy the hands-on approach to learning and for others it gives practical support in learning maths concepts (e.g. using the gears to learn about ratios).
They all learn engineering skills and for some may open up a career path they might not have ever considered.

How to use Robotics in schools – method 1

I introduced a programme which I called Maths Laboratory which was a ”hands-on” practical workshop where pupils worked at cross-curricular problem solving. Pupils worked in two’s at workstations for a 1 and 1/2 hours period each week. They stayed at each work station for two or three sessions and completed a specific project, sometimes one that they had initiated and sometimes one which I specified as an extension of either the maths, science or technology programme.

Within this programme was introduced technic lego kits, and as the robotics programmes were invented I started using them too.
I still run the basic structure of the maths laboratory programme, including robotics as one of the workstations to-day.

Method 2 As an after-school club for interested pupils (usually run by an interested parent) This was the way many American programmes were run. Mostly they worked towards a Robocup challenge or similar competition. Sometimes the programme was run over several days or a weekend at out-of-school holiday camps.

Issues important to the school I- Boys and girls learning
Gender difference

In surveying my Y7 and 8 class of 32 boys and girls I found that all pupils had access to lego at home and up to the age of 7 or 8 both boys and girls played with it.

At ages 11 and 12, eight of the fourteen boys still liked using it to play with. Not one of the girls used it, and stopped using it at 7 or 8 years old.

Initially the ways girls and boys approach the programme are often quite different. Most boys can't wait to get their hands on the equipment and start making something. Almost 100% of the time this consists of quickly constructing a simple vehicle with four wheels, a motor and a battery pack. They are perfectly happy with "driving" this around the room and when there has been enough equipment to make three or four vehicles their main aim is to contrive to crash into as many vehicles as possible. Suggestions for improving their vehicle by maybe adding steering or gears or lights are only of interest when the battery pack is removed from the equation. Other boys who are working on something else always keep a close eye on what the technic boys are doing and making. At the recent international robotics conference it was interesting to hear that boys in America do exactly the same thing! Their male teacher had a different solution to the problem. He initiated a demolition derby where the last robot standing intact was the winner. Yes, the gear is strong enough to stand up to it and it made the participants think about how to make very strong structures to cope with all eventualities -an important need for a remote controlled vehicle. It also highlighted the different gender approaches of male and female teachers!

The way the boys would also keep an eye out, or go and stand beside, watching what their male peers were doing with the robots and not concentrate on their own tasks initially used to annoy me too until I discovered that this was the way they learned best.

There was very little verbal communication but when the first pair of boys had finished their three sessions, the next pair knew exactly what to do and used the first pairs finishing point as their starting point for extending the idea. Generally among the boys the level of skill and knowledge was constant and expanding throughout the sessions as each pair picked up any new knowledge that was happening or could quickly ask for assistance from another pair they knew would help with the solution.

if given a choice many girls would opt to do something else and often tried "Please let me finish...." or " I have a good project idea....(not involving robotics of course)

But we expect everyone to have a go at new things and they were rostered on the same as everyone else in the class.
They sometimes needed a prompt to start and were given a plan to follow showing them how to put things together and construct a model. They were more likely to draw a plan or extend an idea on paper first, whereas the boys almost never did, they preferred to plan by a trial and error approach in making their model. Boys were more happy to change and adapt their models whereas girls did this less. The girls worked quietly and in one place through the session and took little notice of what others were doing. After the frustrations of construction they were amazed that something they made would actually work, the paper crimper crimped paper, the merry-go-round went round. They enjoyed playing with their constuctions and often spent time adding embellishments of lego people or trees or houses to their projects.

In following a plan step-by-step they did not always have a clear understanding of how the mechanism worked e.g. they were not always able to apply the gearing they used for the merry-go-round to another project.
As the programme progressed some girls found they had an interest and ability in the engineering and enjoyed it very much. Their levels of expertise were more individual and wider than the boys, for although they would help each other with problems, most girls did not have that curiosity about the mechanisms of how things worked.

How to interest girls more in engineering was a topic discussed at the recent Robolab conference in Texas. It was discovered that many girls came to engineering because of a parent being an engineer. Girls did not have the same interest or exposure to engineering as boys did. Introducing engineering at primary school gives exposure to engineering to everyone and my experience has been that many girls enjoy the topic.
Another discussion revolved around the types of challenges offered to girls. Not many, if any, were enthusiastic about making and crashing cars. They were more interested in tasks such as making a mechanism for a music box and adding music.

Providing suitable tasks of special interest to girls is something to be considered when organising the programme.

Laura Beals, a graduate student of CEEO presented some research she had done with girls and engineering at the recent Robolab conference. Her paper, Pilot Research: Development of Problem Solving in the Domain of Engineering can be downloaded from
http://www.ceeo.tufts.edu/services/conferences/robolabconference/
Go to 2005 Presentations to find her paper.

How does this fit with the key competencies (integrating knowledge, skills, attitudes and values) and curriculum objectives?

As an introduction to the programme, in discussion with pupils about robots and how they are used and why it would be useful to learn how to make one (see part 2,step 1) pupils are exposed to the many inventors and inventions and the many fields in which robotics are used.

One of the first things pupils learn to do is to make a vehicle, programme it to move forward and stop.

If this task is framed in a humanitarian context e.g. Make a vehicle to carry medication to a person in need across a place too dangerous for humans to walk (minefield, unstable ground etc) it gives a real context and purpose for the exercise.

In key competency *Working with others* the pupils working in pairs must negotiate a joint plan of action, know how to consult other people for help, be aware of why they are working at the project and serve their own and partners interests by forming a good working relationship and work purposefully towards the objective in the time- frame. They also need to be responsible for the equipment so that others using it after them find it intact and workable.

In *Managing Self* it is having a positive attitude towards the task, taking responsibility for listening, watching and learning when others are explaining their solutions so that this new knowledge may be able to be incorporated into a future task and taking the initiative and having the patience to explore further ideas and solutions.

In *Participating and Contributing* it is sharing knowledge and ideas, understanding that this field has and is making an enormous positive difference in peoples' lives.

In *Using Knowledge and Information (Thinking)* the problem solving skills involved in creating a successful, useful project cover every aspect from the initial task question to every step in the process. They certainly cover all the thinking processes and the questions listed.

In Using Language, Symbols and Texts (Making Meaning) the language used is a symbolic one. It shows pupils other possibilities in communicating in a logical and efficient way.

The *technological practice* outcomes- conceptual designs, working models, prototypes, final outcome, would be part of each unit of work.
Technological knowledge is included in the discussion and research components of why and how robotics are used.

The *nature of technology* is introduced when the historical and contemporary developments are examined and discussed.

Curriculum -Technology
There are three strands in the proposed new technology (Technology essence statement 27 July 2005)
A robotics programme covers all three of these in the enhancing and integrative manner suggested by the essence statement and sits well within its definition purpose and aims.

Curriculum - Mathematics
Solutions to problems always use the application of number and algebra. There are specific links to geometry and measurement and statistics. (See example)

Curriculum- Science
With the use of the sensors and/or camera the robotics programme can gather and log data in a range of ways for analysis and understanding the natural world

Curriculum – English
Oral language. Pupils learn new vocabulary to discuss and plan and then explain their models to others.
Written language. At some stages a written report can be used as part of the assessment process where students explain the purpose of their model, the challenges and difficulties they had in making it, how it worked and what they would change, modify or do in a new situation.
Visual Language. A graphical form of language is used in programming.

Part 2: How to set up and run a robotics programme

or

Everything I wished I knew then that I know now

If at all possible go to a course, have a go with the materials then go to another course. It is all those little frustrating things that come up that can be so easily fixed with someone who knows. If possible go to a course with a small group of your pupils. Knowledge is multiplied and what you forget one of your pupils is sure to know. You also get to network with other teachers, share info etc. Being together in one place means you can quickly pick up a lot of information you want to know and a lot of information that you didn't know you needed yet.

Teacher Direct run courses (ring Martin at TeacherDirect
http://www.teacherdirect.co.nz/
for info) and if you are lucky enough to live in Christchurch you can take your class to Science Alive for lessons and workshops.
http://www.sciencealive.co.nz/

However if that is not possible it is still worthwhile going ahead and making a start.

Buying the kit.

Available from http://www.teacherdirect.co.nz/
Download lego education catalogue and buy Robo Technology Core Set with USB tower
Code 9786 $299 or Serial Tower Code 9785, same price.
Also need the software. A single licence 2000076 costs $115.
Buy batteries, a 9-volt for the USB tower and 6 alkaline batteries for the RCX.
(If you want more info on the batteries and some basic troubleshooting go to BernardCatt's 2005 conference report
http://www.ceeo.tufts.edu/services/conferences/robolabconference/
2005 presentations.
This is quite enough to start with if all this is new to you. Later on when things are set up and working you may look at buying more. Showing the BOT or PTA what the children have been doing with the kits is usually very helpful when asking for money.

If you are still uncertain, Teacher Direct are offering on their 2005 catalogue a free trial of a lego robot.
I also strongly suggest that if your children have had little experience with lego, buying a kit such as the simple and powered mechanisms or mechanical engineering and working with that first saves much frustration with the construction processes later.
When the kit arrives. This is when you need a quiet time to concentrate on the loading of the software and the transferring to the RCX. Work with a small group of interested students and go through every instruction carefully step by step. Later on the pupils, from knowing and understanding the set-up are better able to understand how everything works, can problem solve and can reload the RCX firmware etc if needed. Instructions are provided but you might like to look at and download the Quickstart Guide at
http://www.lego.com/eng/education/mindstorms/home.asp?pagename=guide

Leave yourself plenty of time to get the setting up sorted. The Robolab @CEEO site
http://www.ceeo.tufts.edu/robolabatceeo/k12/programming/hints.asp
has good hints and tips and a link to a troubleshooting page

In the Classroom
At all stages involve all the children in your class.
1. Introduction. (a) brainstorm or use other co-operative learning method to find out what children know about robots, what are they? how do they work what are they used for?
(b) Check out some web-sites especially the one with the Mars rover in action
http://robotics.jpl.nasa.gov/
has a group of robots displayed. Look at "urbie "
a good robot to initiate discussion with. Plenty of photos of urbie in action. The language is probably too difficult for many children to navigate by themselves but with a data projector and teacher editing this is a good site.
http://www.jpl.nasa.gov/technology/
has all kinds of robots and images. good discussion starters.
http://photojournal.jpl.nasa.gov/targetFamily/Mars This site shows what is being measured and what data is being collected. Remember that this programme is exactly the same as the one in the technic robotics kit that children will be using. You can check out what is happening to-day on Mars Again teacher help needed.
http://marsrovers.jpl.nasa.gov/home/
has results of missions and some multimedia presentations.

http://www.learnaboutrobots.com/ has many interesting robots. Robots in the News has job descriptions for robotic engineers

This can be a 20-minute starter or part of a larger related project.

Or you could use the introduction in the following web quest for a starter
http://www.hpedsb.on.ca/tyend/robotrek/introduction.htm

2. Set the rules. This is expensive gear and there is nothing worse than when a crucial part goes missing. Decide on where the workstation is, who is responsible for gear, how it is checked at the end of each session, how it is packed away and what happens when the rules are not followed. This is, I know, basic classroom organisation but important.

3.Beginning programming. However you set this up in your class (see Part 1 for how I set up mine) you as a teacher will have little or no time to spend on the two pupils working on it. They have to problem solve their own way through. Fortunately there are some very good beginning programmes to kick-start their learning which they can work at systematically by themselves.
A quick start guide at
http://www.lego.com/eng/education/mindstorms/home.asp?pagename=guide

and the pilot course at
http://www.lego.com/eng/education/mindstorms/home.asp?pagename=qsg_pilot
are useful starters to have downloaded.
You might also use http://www.technologystudent.com/index.htm
Robotics for starting out instructions
There is a lot to understand and process at this stage. Don't hurry it.
Extra activities at this stage.
As a group is finishing their stage, and may not be cycled on to robotics again for another term there are some on-line programmes they might use to retain and extend their knowledge. I prefer to introduce these after the hands-on work with the materials because I think they use it better then. They are also useful for at home use.
http://www.thetech.org/robotics/atyourcommand/index.html
where you control your own remotely operated vehicle
http://www.pbs.org/wgbh/nova/robots/hazard/
You are part of a mission to disable a bomb where you learn about and choose correct robot for specific hazardous mission
http://www.robolabonline.com/
where you programme a buggy on-line and can try a series of challenges
This has a fee attached but you can use it for a trial for free.

4.Setting a challenge.
Lesson Plans
http://www.ceeo.tu,fts.edu/robolabatceeo/k12/cgi-bin/activity_index.cgi

has a variety of lesson plans using engineering and maths components, some with robolab and some with lego components only. They range from ideas for Y2 (see the "gear train" or "away we go" as examples of good science and maths investigations). They have excellent worksheets

Science Alive has lesson planning which shows connection to New Zealand Curriculum
http://www.sciencealive.co.nz/education/primaryprog.html

5. **Evaluating and Assessing** Children keep a diary of their Maths lab activities. It includes tick sheets (for establishing level and stages of work with the quick start programme), print outs, photos and reflection (what could I do better or more effectively, where to next). That and teacher observation form the basis of the assessments.

6. **Extension**
Preparing for a Robocup challenge .CD and workshop available from Teacher Direct (see above)

Project Mars adventure.

http://daviscreek.cabe.k12.wv.us/marscolony2005mappedimage.htm

7. **When things go wrong**
Yes, everyone has those days. You just get set up and the power goes off/the server is down/ computers are being serviced/ the group dynamics in the classroom fall apart. There is 1and1/2 hours ahead with a class of 30 .
Have an emergency back-up plan ready.
Some useful lesson plans, ideas and worksheets are available at
http://www.ceeo.tufts.edu/robolabatceeo/k12/cgi-bin/activity_index.cgi
Set up a class challenge.
A chair for Mr Bear is also an interesting challenge if students are given newspaper and a length of sticky tape to make their model, Exploring Gear Trains, Building a Snow Plough, Catapults, can be done without need of electricity or computers.

Setting up a Maths Laboratory Workstation for a class of 30.
Children work in pairs and are rostered on for two or three sessions.
Number of activities available depend on amount of equipment and computers available.
Example

Station 1	Robotics	Robotics set and computer	
Stations 2 -5	Engineering	Lego kits	
Stations 6-10	Computers	CD's	e.g. Crystal Rainforest Mission Control Kraken (good for younger students) Maths Explorer Web sites -as above Extra Activities Or from TKI Mathematics sites, such As WickED, KidsKount

Crystal Rainforest and Mission Control both have programming components and Kraken and Maths Explorer have good problem solving activities. These and other CD's are available from Edsoft New Zealand email: edsoft@xtra.co.nz for a catalogue.

Stations 11-15 Maths related practical activities. These are design activities related to the Maths programme that can be explored for a longer time tan is normally available in a 40-minute maths lesson.
The Figure –it –Out booklets give some good ideas. 3-D drawing, Tessellations, Symmetry.

Outline of Session

1. Pupils read from list on wall what their workstation for the day will be.
2. Each child plans and set goals for the session by discussion or thinking or drawing a plan or checking next steps from own diary of previous session
3. Collect gear and work at project
4. Sharing time where pupils demonstrate and discuss projects inviting feedback from the group
   Complete journal reflection
5. Tidy up and put away gear.

Writing programmes of work

All programmes follow the same basic engineering design processes

Step 1: Identify the need or problem
Step 2: Research the need or problem
Step 3: Develop possible solution (s)
Step 4: Select the best possible solution (s)
Step 5: Construct a prototype
Step 6: Test and evaluate the solution (s)
Step 7: Communicate the solution(s)
Step 8: Redesign

An Inquiry learning model can be used

LEARNING, TEACHING AND ASSESSMENT PLAN

Inquiry Learning

(derived from inquiry learning model by Kath Murdoch)

THE ESSENTIAL LEARNINGS

From School Curriculum Plan	From School Curriculum Plan

From School Curriculum Plan	From School Curriculum Plan	From School Curriculum Plan
From School Curriculum Plan	From School Curriculum Plan	From School Curriculum Plan

Why this unit? To give children an understanding of Mathematics and Science principles through practical engineering and programming processes

Understandings

Key concepts/ Big Ideas

Find the questions e.g. How can we make our model move?
Observe
Examine
Learn

Process areas (highlight);
Social Sciences: Social, Culture, Place, Time, Resources
Arts: Dance, Drama, Media, Music, Visual arts
Maths: Number, Measurement, Algebra, Geometry, and Statistics
English: Oral, Written, Reading Visual
Technology: Information, Materials, Systems
Science : Physical, Material, Natural, Planet Earth, Nature of Science and Technology
Health and Phys Ed Personal, Movement, Relationships, Communities

Topic …… ……………………………………. Class … ……….. Duration ………………

Tuning in and preparing to find out. Activities to *Engage all students in the topic *Assess prior knowledge * Refine further planning *Lead into the finding out experiences	Use ideas from Introduction 1. (a) and (b) to begin. Survey which children like using lego or If you have available some buckets of lego get the children to invent an amazing machine with moving parts. This will give a good indication of level of expertise and attitude and assist with grouping Demonstrate (by video which comes with kit) what is possible to do with the equipment Plan together some goals and organise a timetable for work times.		**Skills** Decision making Estimating Grouping Hypothesise Listening Organising Planning Predicting Priortising Questioning Visual representation Sharing ideas …………… Comparing & Contrasting Extracting main ideas Inferring Locating and selecting Note-taking Observing Organising Questioning Reading Rcognising bias Scanning Summarising Viewing Analysing Classifying Interpreting Justifying Choosing Organising Performing Persuading Responding Seeing patterns Creativeideas Working cooperatively Generalising Elaborating Modifying Providing feedback Reflecting Revising Self assessing
Finding out Experiences to assist students to gather new information about the topic	**Sorting out** Activities to assist students to process and work with the information and ideas they have gathered about the topic (including exploring values) Specific engineering skills learnt with specific projects e.g. gears with the music box, strong constructions with demolition derby The quickstart programme with labview and mindstorms Challenges from the CEEO website Robocup challenge		
Making conclusions Activities to pull it all together to assist students to demonstrate what they have learned and reflect on their learning	Children talk about and display models with class groups. Take photos or video for record. Share what they have done with children from another class/ parents Journal and/or discuss challenges and problems and learning needs to overcome them		
Going further: Activities to challenge and extend (These may be in the form of further shared experiences , individual or group projects	Could include moving from pilot to inventor mode Being involved in a team challenge e.g. webquest Working towards a robocup junior challenge Competing at a robocup challenge		**Bloom** (see Performa) Remembering Understand-ing Applying Analysing Evaluating Creating

Action: Activities to link theory to practice To empower children to act on what they have learnt and make links to their daily lives	Continue to link engineering principles and mathematics concepts to programme. e.g. making robust pulley systems and using measuring and weighing within maths lessons. Revisit robotics sites or see industrial robots in action to give relevance to the robots they are making		**Thinking Hats** White Black Red Blue Yellow Green

ASSESSMENT routine and records What needs to be done to ensure systematic collection of assessment data	Children keep a journal record Include photos, programming, ideas, problems and reflection. Checklist when completing specific programmes e.g. quickstart. Teacher records levels of achievement, attitude, creativity, technical knowledge and application	

General evaluation notes and suggestions for further planning **(specific details about the learning of individuals against the assessment criteria to be kept with records of student progress)**

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TIFF (LZW) decompressor
are needed to see this picture.

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Going further: Activities to challenge and extend (These may be in the form of further shared experiences , individual or group projects			**Bloom** (see Performa) Remembering Understand-ing Applying Analysing Evaluating Creating