

Pedagogical Strategies for the Technology Classroom

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Wendy Fox-Turnbull

College of Education

University of Canterbury

Christchurch

Email: wendy.fox-turnbull@canterbury.ac.nz

Introduction

Technology is described in The New Zealand Curriculum (2007) as intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities. It gives students challenging and exciting opportunities to build their skills and knowledge as they develop a range of outcomes through technological practice. They bring together practical and intellectual resources in creative and informed ways to engage with the many technological challenges of today's world and of those in the possible future (Keith, 2007). In 2007 New Zealand released a new national curriculum which includes a new national statement for technology education (J.R. Sharrat, 1991, cited in 2007). The statement advocates a holistic approach to the development of technological literacy through the understanding of and participation in authentic technological practice and situated understanding of technological knowledge and the nature of technology. These aspects contribute to the development of technological literacy.

There is clear evidence that due to the practical and socially situated nature of technology education in The New Zealand Curriculum is based on a constructivist paradigm. Conversation with peers and 'experts', about learning is an integral aspect of socially situated constructivist learning. Evidence emerging from recent literature suggests that focused conversations and quality interactions between students and their peers or their

teacher greatly enhances learning. This paper discusses a number of strategies that can be employed in the classroom to enhance students' thinking through conversation.

Technology Education

Technology must be introduced to students within a meaningful child orientated context (Fleer & Jane, 1999, p. 13) and it explicitly deals with technological processes of investigating designing, making and appraising technological solutions to identified problems or recognised opportunities within any given social and cultural context (Fleer & Jane, 1999, p. 73). Compton and France (2006) recognize that technology is increasingly interdisciplinary and requires technologists to work in an integrated manner. Quality technology education programmes that use authentic learning offer an excellent model for inquiry-based learning because they allow integration of numerous curriculum areas (Fleer et al., 2006). In the classroom technology topics can become 'vehicles' for learning from which students can engage in 'worthwhile exploration of meaningful content that relates to and extends [their] life experiences and understanding of the world' (Murdoch & Hornsby, 2003, p 19). Within this sphere of learning, and within technology education, students can be given authentic opportunities to measure, speak, discuss, write reports, and consider all manner of issues.

Strategies for Enhancing the Quality of Student Conversation and Thinking

A Collaborative Approach

Undertaking technological practice has been shown to provide students with the opportunity to collaborate with others and make a difference to their own and others' lives and contribute to developments in their immediate community. This results in high levels of student engagement and allows students to take increasing ownership of their learning and to feel empowered to make decisions regarding the nature of their outcomes. A collaborative approach situates quality technology education programmes within socially constructed or constructivist learning.

The Company Approach

The company approach requires teachers to assign each member of the class to one of two "competing mock companies". Once in their company, the students are 'given' a specific

given brief and maybe asked to appoint a chief executive officer (CEO). The CEO facilitates the division of the company into three teams. Each team is responsible for developing an aspect of one technological outcome e.g. with a food product it may be production, packaging, and marketing. Teams work together to develop a final technological outcome. The division into teams can be done so that students are working in an area of interest which increases motivation and makes most efficient use of time. Alternatively teachers may choose to challenge students but putting them in areas with which they are unfamiliar. Each student undertakes individual technological practice which can be documented accordingly, even at senior secondary levels.

This paper also suggests strategies for enhancing conversations about thinking and learning. Clarke (2003; 2005b) introduces two very effective strategies designed to enhance the quality and quantity of classroom conversation: ‘No Hands Up’ and ‘Talking Partners’. Bloom’s taxonomy offers teachers ideas for enhancing student’s thinking. The Innovative Teachers’ Companion Primary Edition 2006 (I.T.C. Publications, 2005) suggests a number of cognitive or collaborative strategies for each of the levels of Bloom’s taxonomy, although alternative names are given, Bloom’s original names are written the brackets. A description of these strategies is given later in this paper.

Bloom’s Taxonomy

In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behaviour important in learning. Bloom found that over 95 % of the test questions students encounter require them to think only at the lowest possible level...the recall of information. Benjamin Bloom created this taxonomy for categorizing level of abstraction of questions that commonly occur in educational settings Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation.

Competence	Skills Demonstrated
Knowledge	observation and recall of information knowledge of dates, events, places knowledge of major ideas

	<p>mastery of subject matter</p> <p>Question Cues: list, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.</p>
Comprehension	<p>understanding information</p> <p>grasp meaning</p> <p>translate knowledge into new context</p> <p>interpret facts, compare, contrast</p> <p>order, group, infer causes</p> <p>predict consequences</p> <p>Question Cues: summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend</p>
Application	<p>use information</p> <p>use methods, concepts, theories in new situations</p> <p>solve problems using required skills or knowledge</p> <p>Questions Cues: apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover</p>
Analysis	<p>seeing patterns</p> <p>organization of parts</p> <p>recognition of hidden meanings</p> <p>identification of components</p> <p>Question Cues: analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer</p>
Synthesis	<p>use old ideas to create new ones</p> <p>generalize from given facts</p> <p>relate knowledge from several areas</p> <p>predict, draw conclusions</p> <p>Question Cues: combine, integrate, modify, rearrange, substitute, plan, create, design, invent, what if?, compose, formulate, prepare, generalize, rewrite</p>
Evaluation	<p>compare and discriminate between ideas</p> <p>assess value of theories, presentations</p> <p>make choices based on reasoned argument</p> <p>verify value of evidence</p> <p>recognize subjectivity</p> <p>Question Cues assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize</p>

* From Benjamin S. Bloom Taxonomy of Educational Objectives.
Published by Allyn and Bacon, Boston, MA. Copyright (c) 1984 by Pearson Education.
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Below verb examples that represent intellectual activity on each of the four higher levels are listed (<http://www.officeport.com/edu/blooms.htm>.) The ‘Application’ level is included, although Bloom considered this one of the three lower levels of thinking I think it

still has clear links to technology education. Also given in the table below are some examples of questions and activities that will engage students at higher levels, many of which are very applicable to technology.

Application

Useful Verbs	Sample Question Stems	Potential activities and products
solve show use illustrate construct complete examine classify	Do you know another instance where...? Could this have happened in...? Can you group by characteristics such as...? What factors would you change if...? Can you apply the method used to some experience of your own...? What questions would you ask of...? From the information given, can you develop a set of instructions about...? Would this information be useful if you had a ...?	Construct a model to demonstrate how it will work. Make a diorama to illustrate an important event. Make a scrapbook about the areas of study. Make a papier-maché map to include relevant information about an event. Take a collection of photographs to demonstrate a particular point. Make up a puzzle game using the ideas from the study area. Make a clay model of an item in the material. Design a market strategy for your product using a known strategy as a model. Dress a doll in national costume. Paint a mural using the same materials. Write a textbook about... for others.

Analysis

Useful Verbs	Sample Question Stems	Potential activities and products
analyse distinguish examine compare contrast investigate categorise identify explain separate advertise	Which events could have happened...? I ... happened, what might the ending have been? How was this similar to...? What was the underlying theme of...? What do you see as other possible outcomes? Why did ... changes occur? Can you compare your ... with that presented in...? Can you explain what must have happened when...? How is ... similar to ...? What are some of the problems of...? Can you distinguish between...? What were some of the motives behind...? What was the turning point in the game? What was the problem with...?	Design a questionnaire to gather information. Write a commercial to sell a new product. Conduct an investigation to produce information to support a view. Make a flow chart to show the critical stages. Construct a graph to illustrate selected information. Make a jigsaw puzzle. Make a family tree showing relationships. Put on a play about the study area. Write a biography of the study person. Prepare a report about the area of study. Arrange a party. Make all the arrangements and record the steps needed. Review a work of art in terms of form, colour and texture.

Synthesis

Useful Verbs	Sample Question Stems	Potential activities and products
create invent compose predict plan construct design imagine propose devise	Can you design a ... to ...? Why not compose a song about...? Can you see a possible solution to...? If you had access to all resources how would you deal with...? Why don't you devise your own way to deal with...? What would happen if...? How many ways can you...? Can you create new and unusual uses for...?	Invent a machine to do a specific task. Design a building to house your study. Create a new product. Give it a name and plan a marketing campaign. Write about your feelings in relation to... Write a TV show, play, puppet show, role play, song or pantomime about...? Design a record, book, or magazine cover for...? Make up a new language code and write material using it.

formulate	Can you write a new recipe for a tasty dish? can you develop a proposal which would...	Sell an idea. Devise a way to... Compose a rhythm or put new words to a known melody.
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Evaluation

Useful Verbs	Sample Question Stems	Potential activities and products
judge	Is there a better solution to...	Prepare a list of criteria to judge a ... show.
select	Judge the value of...	Indicate priority and ratings.
choose	Can you defend your position about...?	Conduct a debate about an issue of special interest.
decide	Do you think ... is a good or a bad thing?	Make a booklet about 5 rules you see as important. Convince others.
justify	How would you have handled...?	Form a panel to discuss views, e.g. "Learning at School."
debate	What changes to ... would you recommend?	Write a letter to ... advising on changes needed at...
verify	Do you believe?	Write a half yearly report.
argue	Are you a ... person?	Prepare a case to present your view about...
recommend	How would you feel if...?	
assess	How effective are...?	
discuss	What do you think about...?	
rate		
prioritise		
determine		

<http://www.teachers.ash.org.au/researchskills/Dalton.htm> Dalton, J. & Smith, D. (1986) "Extending Children's Special Abilities – Strategies for primary classrooms" pp36-7

To maximise learning we need to encourage all children to think and discuss their thinking and learning with teachers and their peers. The table above give us ideas of the sorts of things we might do with children. Below are some suggested strategies that will enable us to do these things in a varied and interesting way that is relevant to technology education. Also given in the table below are some examples of questions and activities that will engage children at higher levels. Many of these are very applicable to technology education.

Suggested Strategies for Engaging Higher Level Thinking

No Hands Up

Bloom's Higher Levels

Typically in the primary classroom teachers begin a session with a quick recall of prior learning with a question and session with the same few children responding to the questions. Teachers usually have a correct answer in mind and continue until the correct answer is obtained. Clarke (2005b) found that even when an open question is asked the children are thinking stop thinking as soon as the first hands go up. Many children experience this so often that they eventually stop even thinking about the answer because of the constant interruption and the development of the belief that they are less able than their peers. In a 'No Hands Up' children move towards a solution for the problems

mentioned above. All children are asked questions as before, but they are told that anyone may be called on to answer the question. To avoid the 'I don't know' answer teachers are best to avoid recall questions and aim to ask open questions or questions about students' opinions or feelings, which avoid the right or wrong scenario (Clarke, 2005b).

Talking Partners

With all types of questions an effective way for children to respond is to ask the children to talk to a talking partner for 30 seconds to one minute. The answers are then gathered from pairs using 'no hands up' with one pair being the spokes person each time, with the emphasis being on a pair response rather than an individual response. This strategy allows children to think, to articulate and therefore extend their learning and enables less confident children to have a voice and confident children have to learn to listen.

Organisation and training of talking partners is essential regardless of age.

Talking partners have to be set and changed regularly to ensure children experience different ideas and personalities. Clarke (2005b) has found that random pairs seem to be the most effective. A typical time slot for talking partners is about three weeks. When picked the children are to sit next to their new talking partner. If they are working in ability groups then they obviously need a talking partner within their group, so for example they may have three talking partners at a time, one for maths- within their group, one for reading, within their group and one for all other times. Teachers need to ensure children know who they are talking to so it is important that they check for absences and make sure all children are included. Initially teachers should model how to talk with their talking partner with an assistant or another child and creating a set of class rules from the demonstration.

Suggested rules include:

1. look at your partner when they are talking; look interested, nod occasionally
2. don't fidget or let other things distract you
3. let your partner express his or her views
4. think about what the partner is saying; sometime "let go" of what you want to say if you think your partners train of thought is interesting
5. stay focused, try to be clear about what you mean when you speak
6. say more than one or two words; be prepared to compromise or constructively persuade (Clarke, 2005b).

Talking partner can be modified into “Snowballing” when one pair joins another to form fours and take turn explaining their ideas to each other. Fours can then become eights and so on (Clarke, 2005a).

Silent Card Shuffle

Apply (Application)

A cooperative strategy for learning that involves sequencing, classifying, matching, mapping or positioning. Produce a set of 10-30 cards containing relevant words or numbers of the topic to be addressed. Some cards can be duplicated and all cards used to add extra challenge to the activity (I.T.C. Publications, 2005).

1. Children are given a set of cards to sequence or classify and are told to silently organise the cards
2. Children justify and define layout, modifications may be made
3. Circulate, observe and discuss other groups but must not touch or rearrange other groups' cards. Each group may leave an explainer behind
4. Return and refine at their home group based on what they have observed and discussed
5. Teacher debriefing, the value in this strategy is not getting the answers “right” but rather the discussion that occurs during the process (I.T.C. Publications, 2005).

Decision Making Matrix

Analyse (Analysis), Evaluate (Synthesis)

This is a highly effective strategy for comparing and contrasting (analysing), then selecting (evaluating) between two or more items. It is excellent for critical analysis during a unit but also for use as a culminating activity for assessment purposes.

1. Draw up a matrix with the items to be compared down the left.
2. Identify factors, criteria or measures by which to compare and decide. Encourage students to think of as many as possible as the more that are considered the broader the analysis and the better the eventual decision making.
3. Research to find data on the items being compared in relation to the criteria. Note descriptive words or key ideas on the matrix to aid decision making for each item/criteria
4. Rank each item for each criteria on a predetermined scale (1-5 for example, with 1 being doesn't meet or barely meets criteria and 5 being meets extremely well or excels criteria). If some criteria are more important than others they should be given greater weighting. In these cases students can double rankings. A clear decision emerges once the totals are calculated.

This is the strategy used by de Bono's in *Six Thinking Hats* (de Bono, 1992). In this strategy a number of perspectives, each represented by a coloured hat, are identified and used to facilitate thinking around a specific issue: The perspectives are as follows:

A **WHITE** hat - denotes a mode of thinking during which an objective look at data and information is required.

A **RED** hat - denotes the mode of thinking associated with feelings, hunches, and intuition.

A **BLACK** hat - denotes the mode of thinking associated with caution, judgement, and looking logically at the negative aspects of a problem - often described as the 'devil's advocate' mode of thinking.

A **YELLOW** hat - denotes the mode of thinking associated with examining the feasibility and benefits of a given situation, and looking logically at the positive aspects.

A **GREEN** hat - denotes the mode of thinking associated with the generation of new ideas, creative and 'lateral' thinking.

A **BLUE** hat - denotes the mode of thinking associated with the overall control and organisation of the thinking processes (Clarke, 2005b; de Bono, 1992).

Judge Jury

Analyse (Analysis), Evaluate (Synthesis)

This cooperative learning strategy involves students arguing a case on a debatable issue in a court setting. It requires two students (1&2) to analyse the issue from opposite perspectives. They prepare and present their opposing arguments. A third student (3) evaluates both points of view and delivers a verdict.

Suggest rules:

1. 90 seconds allowed for 1 & 2 to present argument
2. Judge (3) referred to as "Your Honour"
3. 1 allowed 30seconds for right of reply after judge has 1 min for note taking after 2 has presented argument
4. Judge allowed 1 minute to complete judgement (I.T.C. Publications, 2005).

KWHL

Analyse (Analysis)

An effective strategy for engaging learners especially at the start of a unit. The acronym stands for:

K- What do I Know?

W- What do I Want to know?

H- How will I find out?

L- What have I Learnt?

What do I Know? A fundamental component of the constructivist classroom is the identification of what students already know. Strategies such brainstorming and Concept mapping can be used to establish what is known.

What do I Want to know? Allowing the students to manage their own learning ensures better engagement and a great chance of achieving intended outcomes.

How will I find out? The emphasis must be on consideration of a wide range of resources as students enter the inquiry phase of the unit. Students can seek answers in books, internet, databases, CD, DVDs through interviews with stakeholders and other relevant people.

What have I Learnt? Completed at the end of the unit, students and teachers consider what they have gained from the experiences, what conceptual understandings and ideas are gained. This is an excellent reflection exercise (I.T.C. Publications, 2005).

PCQ (Pros, Cons, Questions)

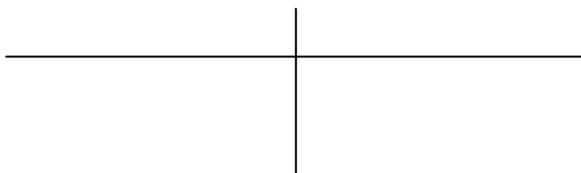
Analyse (Analysis), Evaluate (Synthesis)

A basic tool for the critical thinker and used when thinker is attempting to analyse a decision before making a decision. The 'Pros' column invites one to list all the benefits, strengths, plusses, advantages of an idea from as many points of view as possible. The second column 'Cons' deals with the negative aspects, contra ideas, disadvantages, weaknesses of an idea. The 'Questions' column offers an opportunity to questions, curiosity, probing and 'what ifs'. To help develop the divergent thinking stems such as 'I wonder...' 'What if...' or 'It would be interesting to know...' can be used for the 'Questions' column. This column allows us to see children who have remarkable insight into designs or issues (I.T.C. Publications, 2005).

T Charts

Analyse (Analysis)

A simple chart to allow learners to extract and record information with a framework for visual presentation.

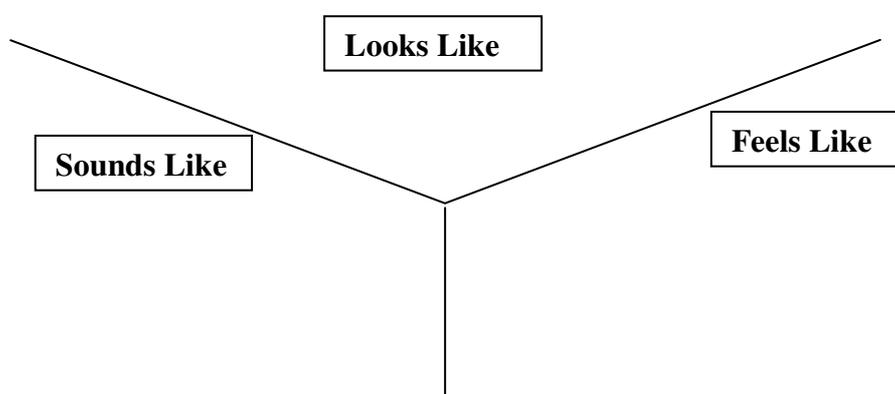


This is useful for when looking at something in detail and can be done individually, in pairs or groups. If working in pairs it can prove interesting to get each member filling in one side each. Good for opposing points of view such as; fact/opinion; true/false; objective/subjective; healthy/unhealthy; safe/unsafe; advantages/disadvantages. (I.T.C. Publications, 2005)

Y Charts

Analyse (Analysis), Evaluate (Synthesis)

This is a powerful strategy that encourages learners to see beyond the obvious and create greater depth of understanding about a topic. It allows abstract qualities to be perceived in concrete terms.



In the Looks Like segment students list things that they would see concrete things such as car bus and also abstract things such as anger, frustration. In the Sounds Like section students can be encouraged to not only remember words and conversation but also to empathise with both sides of an argument or imagine what internal dialogue might be going on with participants. In the Feels Like section students can use tactile as well as emotional and spiritual feelings. Empathy can also be encouraged here. To maximise value from the Y Chart prepare the students with a rich vocabulary of adjectival responses and do not end the exercise too early as persistence leads to more insightful thinking. It is an excellent catalyst for thinking of ideas to meet a specific technological need e.g. design an improved natural looking fish tank (I.T.C. Publications, 2005).

Tournament Prioritiser

Evaluate (Synthesis)

A strategy used to develop core or most relevant ideas from a list of ideas. It uses a sports tournament organiser. The process aids students who often have difficulty identifying most important aspects or ranking the aspects according to order of importance. The steps include: generation of a list from a topic. Transfer list to the left side or first round of a

tournament organiser sheet noting the first idea at the top and second idea at the bottom and so on. Students are now in a position to compare two ideas and knock one out rather like in a tennis tournament, by debating the relative values of the items, the winner advancing to the next round. The process continues until a winner is declared (I.T.C. Publications, 2005).

1:4:P:C:R Publish, Circle, Refine

Design (Evaluation)

This strategy calls for creative thinking, critical reflection, risk-taking, editing, drafting and a sense of humility. It can be used to explore “isms” (e.g. professionalism) and leads to far deeper understanding than is gained without it. It also encourages learners to listen and to have a sense of ‘the organic nature of learning’ (I.T.C. Publications, 2005, p. 86). It involves all learners and the resulting hybrid product can be extremely motivating. Students work in groups of four, topics might be such as ‘What is Professionalism?’ or ‘Create a design for.....’

Create a first draft in silence for 3-20 minutes (Publish)

Share your ideas with the group and discuss the different definitions/ designs 5-15 minutes

Create a combined definition/ design and write this clearly onto an A3 sheet using a thick pen 5-10 minutes

Post on the wall and leave one person behind as the “explainer” or “defender”. In groups of three move around the room reading and discussing the contents of others and challenging the explainers. Take notes as they progress around the room. (Circle)

Return home; discuss the notes made and the new understandings generated from circling around the room. Discuss ways to improve the published definition/ creation (Refine).

Refine the product and share with the whole class (I.T.C. Publications, 2005).

MASC

Design (Evaluation)

A great tool to help students with design tasks such as redesigning everyday items. This acronym represents:

M Modify

A Add

S Size

C Change

It is highly recommended for use in small groups allowing the students to generate a number of creative ideas through team work. The steps involved are:

- Modify a feature or replace one part with another
- Add a new feature to the object

- Alter the size of one or several parts
- Change one aspect such as the shape, texture, colour, or ergonomics (I.T.C. Publications, 2005).

Word Association

Design (Evaluation).

This is ideal for use when students feel that they are not creative, this strategy is used to generate new ideas and or find creative solutions for a problem.

Students decide on a subject for which a new solution is needed

Then think of a word or object that has nothing to do with the topic needing new ideas.

Write the name of the object in the middle of the page. This becomes the launch pad

Students then use their imagination to think of associated words, opposite, puns etc.

This continues out in a linear fashion until they think of an idea that could transfer to their original problem, they put a box round this idea. Students then start again from the launch pad and look for more word associations. Students can give their brains permission to be silly, exciting, different, or even a bit crazy (I.T.C. Publications, 2005).

Conclusion

This workshop has been aimed at engaging you as technology teachers in activities that you could implement in technology education at almost any levels, with any children from a range of backgrounds and abilities. I firmly believe that we can teach all children to think and by doing so enhance their motivation and often their self esteem.

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