

# [The last 20 years have brought many changes to the teaching of mathematics, as we...](https://assignbuster.com/the-last-20-years-have-brought-many-changes-to-the-teaching-of-mathematics-as-well-as-to-the-content-the-toolstrategies-and-the-focus-of-mathsnumeracy-lesson/)

[Business](https://assignbuster.com/essay-subjects/business/)

‘ In light of this statement, discuss and evaluate a range of approaches impacting on the teaching and learning of mathematical skills with reference to: \* At least two current appropriate theories of mathematical skills acquisition, knowledge and learning \* Current research and specialist publications \* At least two learners with whom you work ‘ Numbers saturate the news, politics, life. For good or ill, they are today’s pre-eminent public language – and those who speak it rule. Blastland ; Dilnot, 2008

For the purposes of this essay: Learner A: a 22 year old female ESOL learner with ESOL reading and writing skills to Level 2, working towards her Level 2 OCR numeracy exam. She aspires to start her Access to Nursing course in September 2012.

Learner B: a 40 year old female, Plymouth-born learner with low self-esteem and maths anxiety. She has been bringing up her children and now wants to gain a numeracy qualification so she can have more options when she returns to work. She is progressing towards an Entry 3 qualification. 1. The origins and status of mathematical knowledge on mathematics curriculum development: Gardener (1989) postulated that all humans possess differing degrees of innate mathematical ability which he termed, ‘ logical mathematical intelligence. ‘ It gives individuals the capacity to investigate problems scientifically, analyse results logically, detect patterns and reason deductively.

In ancient civilizations mathematical intelligence was used to develop systems which regulated commerce. Maths skills were taught in ‘ schools’ and the academic discipline of mathematics was born, Ernest (1986).

Ancient civilisations distinguished between maths for scholars (Relational Understanding) and maths for vocational trades (Instrumental Understanding)Hilton1980. This division is reflected in our culture today: – \* Numeracy for functional use, ‘ equips students for life beyond school in providing access to further study or training, to personal pursuits, and to participation in the world of work and in the wider community’ Booker (1997). \* Matheracy in academic study, involves more than counting and measuring for everyday life.

Ubiratan d’Ambrosio, (2006), describes it as being concerned with a deeper reflection.

It draws conclusions from data to propose hypotheses. How the designers of maths curriculums combine the two disciplines of mathematics defines the society in which we live. The content of the maths curriculum in the UK over the past twenty years has been highly contended by five distinct groups with differing values, interests and ideologies categorised by Ernest in Appendix 1. Consequently, the curriculum targets adopted are a hodgepodge of principles encompassing basic skills, problem solving for practical problems at work and some pure maths.

Targets aimed at using and applying mathematics processes are included to a lesser degree.

The aims of the democratic socialist and radical reformers concerned with social justice who proposed the empowerment of learners as mathematically literate citizens in society were largely ignored. Furthermore, the past twenty years has seen a widening social inequality as educational policies have not only failed in their objective to make learners more functionally numerate but also reduced the critical thinking skills encouraged in matheracy.

In a Radio 4 broadcast, ‘ Things ain’t what they used to be’, (May 2012), Aaronovitch examines the paradox that the more society becomes reliant on the functionality of maths, the more rapid the decline of individual’s ability to think logically. Individuals are exploited by statistics and number-based systems which are understood by few but which invade and control every aspect of everyday life in Postmodern Western materialistic societies. In my evaluation of teaching approaches in the skills for Life Sector I am considering the following: \* What mathematical skills need to be taught?

Matheracy or numeracy or both? Do learners need to understand the concept behind their numerical world or just be able to interact functionally with it? \* As learners differ in the innate genetic mathematical intelligences, how can maths knowledge and skills be taught so that all students are able to access the curriculum? \* As the chasm widens between the complex and simple numerical systems which define our ‘ everyday’ life, how can skills taught in the classroom be made relevant and transferred to the learner’s life and work outside of the classroom? 1. The Curriculum over the past twenty years: In his Ruskin speech (1976), Callaghan (Prime minister, 1976 – 1979) initiated the decline of Progressivism and the increasing importance of Instrumentalism by openly criticising the British education system and suggested that school should prepare children for work.

The UK maths curriculum became linked to its Gross Domestic Product. In 1999, a Fresh Start, a report commissioned by the Department of Education and Employment linked the National Curriculum to the economy by estimating the cost to the UK of poor basic skills at ? 0 billion a year. The Blair Government undertook to, ‘ remedy at public expense the shortcomings of the past,’ by creating The Skills for Life (SfL) strategy. As a consequence, The Qualifications and Curriculum Authority (QCA) and the Basic Skills Agency (BSA) developed new Skills for Life curricula which was first published in February 2001, The SfL Curriculum was broken into three main sectors: Number, Measure Shape and Space and Handling Data. Each sector is broken into five levels ranging from Entry1 – Level 2.

It was a cumulative, vertically structured curriculum based on Constructivism, a paradigm for teaching and experiential learning first proposed by Dewey, 1938.

Learners are motivated by challenges slightly above their previous experience as suggested by Vygotsky, 1978: for example, in ‘ Number’ skills build from reading and writing whole numbers in words and figures (Entry 1) to fractions (Entry 2), decimals (Entry 3) and eventually to include percentages (Levels 1 and 2). The tutor is a facilitator who provides the environment for learning then guides learning through open questions which encourage exploration.

The Constructivist Approach benefits adult learners in accordance with the theories of Andragogy, Knowles 1980. Adult learners vary considerably in their innate mathematical abilities and in their experience of maths. The combination of nature and nurture results in Skills for Life learners having vastly differing spikey profiles. Engaging them in tasks which encourage them to share their experiences and motivate each other promotes dynamic interaction and motivation to learn.

Despite the SfL Curriculum, the UK continued to flounder in a Global Market.

In 2006 disclosures made by the Leitch Report, ‘ Prosperity For All in A Global Economy’, commissioned by the Treasury, found that the UK ranked a disappointing 12th out of 18 comparative members of the Organisation for Economic Co-operation and Development (OECD). Nearly half the 48million adults in the UK workforce had numeracy skills less than grade ‘ C’ GCSE. In the Skills for Life Sector there was a paradigm shift from Constructivism to Situated Learning where the focus is on embedding learning by doing and on addressing real problems.

Proposed by Lave & Wenger (1991), it is not classroom dependent but involves Communities of Practice. For example, in an apprenticeship where an ‘ oldtimer’ engages a new comer in ‘ legitimate peripheral participation’ enabling students to acquire, develop and use cognitive tools in authentic activities, Brown et al (1989).

The Learning and Skills Improvement Service (LSIS) developed a subtly new curriculum for numeracy in 2007. Support on how to embed the curriculum at all five levels in vocational areas was proffered on the excellence gateway website.

Evidence provided by National Research and Development Centre for Adult Literacy and Numeracy (NRDC) (2006), and analysed in Module 1, Assignment 1a, (A detailed analysis of a vocational learner’s mathematical knowledge and skills with reference to their math’s history, experiences and vocational needs) establishes that situated learning of functional numeracy is most effective if it is fully or partially embedded in a vocational curriculum, replicating Greek Instrumentalism, Lave (1988).

Recreating authentic domains in a classroom is inherently difficult. As discussed at length in Module 2, assignment 1a, the language needed to ‘ set the scene’ overcomplicates problems and causes unnecessary panic in maths anxious learners.

ESOL learners, often very adept in the workplace and with high numeracy skills find Functional Skills Maths exams extraordinary difficult as they are made up of contextualised vocabulary which is specific to a very small range of topics presented in the abstract.

A damming review of The Skills for Life 14 – 19 system, The Wolf Report, commissioned by the Department for Education (2011) estimated “ that at least 350, 000 (learners) get little to no benefit from the post-16 education system. An Instrumentalist curriculum is failing these learners because over the past twenty years, and especially evident since the crash of the Global Economic Market in 2008, ferocious competition for jobs and places on courses requires learners to have acquired numeracy skills which they are able to adapt and transfer to vocational settings before employment/training is even ffered. An example is provided by nurse training which in 1990 became focused more on academic preparation in universities and away from practice-based training in hospitals. For September 2012, King’s College London had 5, 679 applicants for its 461 places, Snow (2012).

In the work place, despite a recognised need for improved numeracy skills situated learning is expensive and avoided by employers in times of recession. The National Evaluation of Sure Start (NESS) 2006 indicated that a significant minority (39%) of the workforce did not receive numeracy training.

Evaluating the impact of SfL approaches to teaching numeracy on the learner Disturbingly, a socio-economic gap is developing between learners with transferrable numeracy skills who can access more jobs and training opportunities and learners who cannot. The reality for Learner B is that an Entry 3 qualification in numeracy has little worth in the highly-skilled or intermediately-skilled job market where ‘ one in five UK university leavers who entered the labour market failed to find a job last year’ (BBC News January 2011). Her Entry qualification will be valued in soft-skilled areas and low-skilled sectors, Ananiadou et al.

2004. Constructivist approaches have helped her grasp numeracy skills and situated learning techniques helped her to apply the skills to a real life problem but is she able to adapt the skills to any sector in which she is employed? Learner A is predicted to achieve her Level 2 this term and has a conditional offer for her Access course. However, after July 2012 The Government is not funding OCR Level 2 courses because in 2011 NAICE in The Final Report, sought to ‘ re-balance public funding to support numerate behaviour rather than skills, and for qualifications to be a goal for some rather than a drive for all. Soon the only funding at Level 2 will be for Functional Skills courses. Learner A enjoys solving functional problems in a classroom setting.

New, low-frequency vocabulary is explained during dynamic interaction with other learners in approaches promoted by Constructivists. However, as a qualified ESOL teacher I am convinced she would struggle with the vocabulary for topics on a Functional Skills exam. Learner A would benefit most from situated learning embedded in an authentic work-based curriculum – would this be easily transferred to other situations? 3. 1 Summarising the nature of argument in mathematics:

Despite the variation in innate logical mathematical intelligence between individuals, Gardener (1989), all learners benefit from understanding the concept behind their numerical world. It enhances their ability to interact functionally with number systems.

(See Module 1, assignment 2a, Discuss Public/Popular Perceptions of Mathematics and Numeracy and the Impact on the Learner). It allows operative generalisation – skills used to solve problems in one context can be transferred to solver multiple activities, Dorfler, 1991. Algebra, once reserved for high level matheracy is introduced to lower level numeracy.

The tools and strategies used for teaching numeracy have been adapted over the past five years. There has been a swing away from the Transmission Culture which sees maths as ‘ disembodied abstract knowledge made up of facts, rules and algorithms’ Nicksen (1985) to be ‘ covered’ by a teacher.

Collaborative approaches have been embraced which encourage learners to ‘ develop a critical stance towards maths and the broad contexts in which maths resides’ Tout & Johnston (1995). Problems are presented before an explanation which gives learners the freedom to explore meaning and connections, develop and then test their own concepts.

Topics are presented as ‘ a network of ideas which teacher and students construct together. ‘ Deductive reasoning, involving chains of statements that are logically connected is embraced. Learners are encouraged to experiment and generalise results made from a few observations.

Inductive reasoning is used in the formation of ‘ proofs’ which are then tested using different variables until learners are able to provide a logical argument based on the empirical evidence of their findings and stated assumptions. See Appendix 2: Conflict and Discussion Approach & Evaluating Mathematical Statements: Collaborative Learning in Mathematics. Swan, 2006) Developing and evaluating proofs is a characteristic of matheracy developed by the ancient Greeks. It boosts critical thinking and soft-skills such as common-sense, team work, problem solving, communication, planning and organising which can be transferred and integrated into workplace tasks FitzSimons et al. (2005).

Common proofs used in school mathematics are: direct proof, proof by exhaustion, proof by contradiction, existence proof and proof by mathematical induction.

Examples of these different proofs are explained in Appendix 3, The Nature and Role of Reasoning and Proof, (Mathsforum, 2007) 3. 3 Defining and representing different concepts in numeracy; The dramatic change in presentation of maths concepts over the past five years has had a positive impact on my leaners: In my practice, five years ago teaching methods for my Entry Level Learner B would have been based on Constructivist activities; building skills to be used to solve an isolated problem in the context it was presented.

For example, learn how to add, multiply and subtract: Combine skills in a role play activity to complete a shopping exercise and work out change. The Constructivist Approach assumes that if a learner can solve a problem they understand the mathematical concept associated with that problem. If mistakes arise, Socratic questioning is used to unearth misconceptions.

If all else failed, repetitive learning by rote methods, advocated by the Behaviourists (Skinner, 1938), are employed. For example, ‘ whatever you do to the bottom of a fraction you MUST do to the top’.

This Surface Learning (Marton & Saljo, 1976) resulted in the correct answer but the lack of deep understanding meant the skill was easily confused when variables changed and therefore not transferrable, (Godino, 1997). In stark contrast, Collaborative teaching methods encourage Learner B to understand mathematical concepts by examining simple direct proofs during ‘ always, sometimes or never exercise’ style discussion activity (see Swan, Appendix 2, page 15 – 20). For example: Is it always, sometimes or never true that: \* A pentagon has fewer right angles than a rectangle? a x b = b x a? It doesn’t matter which way round you multiply, you always get the same answer.

\* 12 + a > 12? If you add a number to 12 you get a number greater than 12 Theorems can be ‘ discovered’ and discussed at Entry Level by Learner B. A favourite is a problem posed by Euler (1735): Is it possible to cross seven bridges without crossing any of them twice? Practical application of the theorem postulated to solve the problem of the bridges of Konigsberg is a good introduction to topology and transport maps e. g. the London underground.

Learners are encouraged to think for themselves, discuss problems with their peers and work collaboratively.

Evidence for direct proofs at Entry 3 is visual. Formula, using algebra for generalising, can be discretely introduced. Collaborative approaches to teaching embrace misunderstandings as opportunities to develop analysing, reasoning and critical thinking (Appendix 3, page 29 for examples). Learners analyse their answers and discern between a misunderstanding of a concept and an incorrect answer due to an arithmetical slip.

Emerging abilities include: recognising the difference between anomalous effects and wrong answers and communicating mathematical judgements clearly and concisely.

These are invaluable in the workplace, (Wolf, 2005) and are in conjunction with the aims of The Cockcroft Report (1982), ‘ Our concern is that those who set out to make their pupils ‘ numerate’ should pay attention to the wider aspects of numeracy and not be content merely to develop the skills of computation’. Soft-skills practiced during discussion have motivated Learner B, boosted her self-esteem and given her numerical confidence.

Examples of Collaborative activities for Learner A include exhaustive proof methods to ‘ discover’ ? experimentally (Appendix 3) and deducing generalised algebraic formulas which can be used to work out the circumference and area of any circle (The Adult Core Curriculum, page 71, DfES 2001). She is also able to engage in proof by contradiction for example assuming there is a finite number of prime numbers to prove there is an infinite number of prime numbers (Appendix 3, proof by contradiction).

The Collaborative tutor’s role at Entry Level is to ask effective questions, for example, ‘ how can you…..

? ‘, ‘ Why did you….? ‘ 3. 2 Analysing the interpretation, representation and misinterpretation of data: ‘ it might be Bedlam out there but, once averaged, the world turns smooth. ‘ Blastand & Dilnot 2008. Ironically, in 1967, the prisoner in a cult TV series of the same name, remonstrated; ‘ I will not be pushed, filed, stamped, indexed, briefed, debriefed or numbered.

My life is my own .

.. Number 6: I am not a number, I am a free man. In the decades since, we have embraced a revolution in Information and Communication Technology (ICT) and surreptitiously, every detail of our lives has become a statistic – digitally monitored, assessed, compared and evaluated. Even success and failure are quantified numerically, Foucault 1976. In Appendix 1, Ernest (1986) lists the diverse arenas where complex numerical systems, understood by few, are used.

Depressingly, Ernest (1986) postulates that reality in our post-modern consumerist society is defined by finance and balance sheets which go unchecked because only those with elite maths skills can scrutinise them. This is ironically highlighted in the preface of Alchemists of Loss, Dowd, K & Hutchinson, K (2010): a book intending to describe how modern finance almost destroyed our Global economy recommends the reader skips the chapter on mathematical analysis because it too ‘ dense’.

Paradoxically, Sternberg (1997) purports innate logical mathematical intelligence and higher-order conceptual thinking skills have been enhanced by ICT yet we seem unaware we have forfeited our freedom. This may be because functional technology is lucrative. Wolf, 2005, reported that the proportion of workers for whom ICT is essential at work rose from 31 to 40% between 1997 and 2001, and that this percentage is higher in some sectors.

Those with good conceptual and technological skills will increasingly be able to advance to more meaningful and higher-paying jobs, whereas those without these skills will increasingly be relegated to lower-level jobs. This is exasperating socioeconomic polarisation. Blastand & Dilnot, 2008 explain how numbers can be used to pull the wool over our eyes. They give the example of a ‘ white on average’ rainbow which ‘ bleeds all that matters from the original’ Similarly, numbers are used to shock, amaze, alarm and manipulate.

Critical thinking skills taught by Collaborative teaching approaches encourage learners to interpret statistical data, question anomalies, test findings using other variables, contest and discuss results with colleagues and most importantly not to simply accept them.

In the classroom, lower-order, more routine numeracy skills are promoted because an over-reliance on calculators and a fixation with numerical manipulation can impede learners in their ability to critically analyse their answers to make sure they are sensible. It also hampers their progress in representing abstract generalisations in the form of algebra, Orzel, 2005. . 2 Local, National, International research and Learner Feedback: “ Unlike mathematics that does not depend on context, numeracy moves outward toward an ever richer engagement with life’s diverse contexts and situations” (Orrill 2001) Research from USA into quantitative literacy summarises the challenges faced by the curriculum planners over the past twenty years as numeracy strives to include the ever changing quantitative demands of day to day modern life. Researchers prescribe subtle adaptation of traditional mathematics curriculums to, Ottill 2001.

The Centre for Innovation in Mathematics Teaching (CIMT) established in 1986 and based in Plymouth, UK, extends the collaborative teaching approach into Continued Professional Development (CPD) by encouraging schools, colleges and practitioners to share their experience, reflect and discuss their best practice.

As a direct result of discussion with colleagues during my ADTLLS course, I am trying to incorporate Collaborative teaching activities in my teaching. Change is challenging, I habitually revert back to the leading Socratic questioning of the Constructivist Approach.

However, it is obvious that Learner B and Learner A have both benefited from collaborative methods. For example, they are both happy to declare, ‘ that’s not right’ if they have tested an answer and found it wanting. Ensuing discussions are natural and student-led.

Nationally, there the key organisations involved in the SfL strategy have amalgamated and metamorphosed over the past twenty years. Today, approaches to my teaching practice are informed by research conducted by many experts in the field and published by the NRDC.

The Excellence Gateway website provides suggestions for activities and resources. Skillsworkshop is another invaluable resource into subtly changing and imaginative approaches to teaching topics. In conclusion, my teaching is a blend of approaches: Situated Learning encourages learners to be pragmatic in their approach to numeracy.

It embraces ICT and this enhances higher-order conceptual thinking. Constructivist approaches provide the belt and braces skills needed to manipulate numbers and redress the decline of the individual’s ability to think logically.

Collaborative methods provide critical thinking skills essential for analysis which prepares individuals for the work-place and helps them to be less susceptible to exploitation by statistics and the number-based systems which invade and control every aspect of everyday life in Postmodern Western materialistic societies. Word count: 3322 including headings and brackets Bibliography: Ananiadou, K. , Emslie-Henry, R. , Evans, K.

and Wolf, A. (2004): Identifying Effective Workplace Basic Skills Strategies for Enhancing Employee Productivity and Development. NRDC. London.

Blastland, M ; Dilnot, A (2008): The Tiger That Isn’t: Seeing through a world of numbers.

Profile Books Ltd. London.. Booker, G. , Bond, D.

, Briggs, J. & Davey, G. (1997) Teaching Primary Mathematics (2nd Edition), Longman Cheshire: Melbourne Brown, John Seely , et al. (1989). Situated Cognition and the Culture of Learning The Cockcroft Report (1982); Mathematics counts. London: Her Majesty’s Stationery Office Dewey, J.

(1938). Experience and Education. Simon and Schuster. New York: Ernest 1986, Publisher: London University Institute of Education, Volume 9, Pages: 1-14 Dorfler, W. 1191): Forms and Means of Generalisations in Mathematics.

Sited in: Mathematical Concepts, their Meanings and Understanding. Godino, J. Class hand out. ADTLLS, Hooper, G. City College Plymouth. May 2112.

Dowd, K ; Hutchinson, K (2010): Alchemists of Loss: How modern finance and government intervention crashed the financial system. Wiley ; Sons, West Sussex, UK Foucault, M. (1976): Discipline and Punish: The birth of a prison. Hammondsworth, Penguin, UK FitzSimons, G. ; Mlcek, G. (2005): Adult Literacy Research.

Learning numeracy on the job: A case study of chemical handling and spraying.

NCVER, Adelaide Gardner, H. ; Hatch, T (1989): Multiple Intelligences Go To School: Educational implications of the theory of multiple intelligences. Educational Researcher Hilton, P. J.

(1980). Math Anxiety: Some suggested causes and cures, Part 2. Mathematic Journal. Hudson, C (2007): Working mathematics for the 21st century? A discussion paper on workplace numeracy and mathematics. NRDC.

London Knowles, M (1980). The Modern Practice of Adult Education: From pedagogy to andragogy: Association Press. Wilton, Conneticut Lave, J. (1988). Cognition in Practice: Mind, mathematics and culture in everyday life.

London.

Cambridge Press. Lave, J. Wenger, E (1991): Situated Learning: Legitimate Peripheral Participation. Cambridge University Press. Cambridge Marton, F ; Saljo, R (1976): On Qualitative Differences in Learning: Outcome and Process. Brit.

J. Educ. Psych. NIACE (Chaired by Mary Marsh), (2011): NAICE Committee of inquiry on Adult numeracy Learning – Final Report. NAICE.

Leicester. Nickson, M. (1985): Perceptions of Mathematics and The social context of The Mathematics Classroom. Paper for the 5th International conference on Mathematics in Education.

Adelaide. Skinner, B.

F. (1938): The behavior of organisms. Appleton-Century-Crofts. New York Snow, S (2012): Get into Nursing ; Midwifery. Pearson Education. LondonTout, D ; Johnston, B (1995): Adult Numeracy Teaching: Making meaning in mathematics.

National Staff development committee for Vocational Education and Training. Melbourne. Vygotsky, L. S. (1978). Mind and Society: The development of higher mental processes.

HarvardUniversity Press. Cambridge, M. A. Wolf, A. (2005): The Change Agenda.

Basic skills in the workplace. opening doors to learning.

Chartered Institute of Personnel and Development. LondonWebliography: Aaronovitch, D (2012): ‘ Things ain’t what they used to be’ Radio 4. original broadcast 15.

05. 12BBC News, Education and Family Graduate unemployment at highest for over a decade: , January 26th 2012. http://www. bbc. co.

uk/news/education-12286264 (Accessed 25. 05. 12)http://www. bbc. co.

uk/programmes/b01hjs15 (Accessed 25. 05. 12) Excellence Gateway Websitehttp://www. excellencegateway. org.

uk/ (Accessed 30. 05. 12)| Godino, J: Mathematical Concepts: their meaning and understanding http://www. gr. es/~jgodino/articulos\_ingles/meaning\_understanding.

pdf (Accessed 25. 05. 12) James Callaghan: Towards a national debate: http://education. guardian. co.

uk/thegreatdebate/story/0,, 574645, 00. html (Accessed 13. 02. 2012) NESS 2006: National evaluation of Sure Start local programmes: An economic perspective https://www. education. gov.

uk/publications/RSG/Surestart/Page1/DFE-RR073 (Accessed 27. 05. 12) NRDC Publications: Maths4Life Working mathematics for the 21st century? http://www. nrdc. org. uk/publications\_details.

asp? ID= 119# (Accessed 26. 50. 12)

NRDC 2006 ‘ Embedding literacy, language and numeracy in post-16 vocational programmes – the impact on teaching and learning http://www. nrdc. org. uk/content.

asp? CategoryID= 1026; ArticleID= 887 (Accessed 10. 03. 12) NRDC: A Fresh Start: Improving literacy and numeracy. The report of the Working Group chaired by Sir Claus Moser. 1999 http://www. nrdc.

org. uk/anr\_details. asp? ID= 135 (Accessed 25. 05. 12) Orrill, R (2001): Mathematics, numeracy, and democracy, http://www.

maa. org/ql/fm13-20. pdf (Accessed 30. 05. 12) Orzel, C (2010): Real Math Doesn’t Use Calculators. http://scienceblogs.

om/principles/2010/07/23/real-math-doesnt-use-calculato/ (Accessed 25. 05. 12) Skillsworkshop http://www. skillsworkshop. org/ (Accessed 30. 15.

12) Sternberg, R. J (1997): Technology Changes Intelligence: Societal Implications and Soaring IQs. TECHNOS QUARTERLY Summer 1997 Vol. 6 No. 2.

Yale http://www. ait. net/technos/tq\_06/2sternberg. php (Accessed 22. 05. 12) The Prisoner, 1967: Memorable quotes: http://www.

imdb. com/title/tt0061287/quotes (Accessed 30. 05. 12) Ubiratan d’Ambrosio (2006) : Literacy, Matheracy and Technoracy – The New Trivium for the Era of Technology http://www. ottingham. ac.

uk/csme/meas/plenaries/ambrosio. html (Accessed 16. 02. 12) Wolf Report, 2011; Review by the Department for Education https://www. education. gov.

uk/publications/standard/Post16Learning/Page1/DFE-00031-2011 (Accessed 25. 05. 12) Appendix 1 – ADTLLS, Class hand-out, 02. 05. 2012 Why Teach Mathematics? Paul Ernest University of Exeter Appendix 2: Conflict and Discussion Approach ; Evaluating Mathematical Statements: Collaborative Learning in Mathematics. Malcolm Swan, 2006 Appendix 3 – ADTLLS, Class hand-out 16.

05. 12 The Nature and Role of Reasoning and Proof