Promoting Education in Human Values in the Regular Mathematics Classroom

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Introduction

In the past, human values have been regarded as the basis of society in civilisations throughout the world, regardless of their religious or cultural beliefs. These values include:

- the development of general knowledge, common sense and problem-solving skills;
- perseverance in the face of difficulties;
- unity, co-operation and team-work to achieve common goals;
- tolerance, understanding and accepting differences between individuals:
- honesty and truthfulness;
- inner harmony and outer peace as fundamental ways of getting to create peace on a wider scale - between family members and friends, between neighbours, regions and countries;
- compassion for other beings (human, animal or plant),
- giving time and effort to others willingly and without any expectation of physical or emotional reward;

In recent times there appears to have been a swing away from these values, as people have become more concerned with materialism, power and self.

For the many reasons outlined below, the state of society - in Hong Kong as well as globally - has reached a stage where it is more critical than ever to educate people in traditional values (see Table 1 for examples) that have been lost and forgotten over time. Many writers have documented concerns about the rapidly rising occurrences of violence, crime, drug taking amongst adolescents and adults (Lockwood, 1993), and the corresponding decline in respect for authority, politeness, and concern for themselves and others (Lockwood, 1993). In recent years there has been considerable discussion about whether it is the responsibility of schools to impart values education and those who have tried to do so have often been regarded with suspicion (Jennings and Nelson, 1996). On the other hand, there is the argument that it is impossible for teachers to avoid imparting values in

some way (Newman, 1994) and so therefore the issue becomes how it should best be done rather than whether it should be (Carbone, 1991; Carr, 1997). There is growing pressure for all teachers to become teachers of values, through modelling, discussing and critiquing values-related issues (Noddings, 1991; 1995a; 1995b; 1995c; Jennings et al., 1996; Lockwood, 1993). Education can no longer be concerned solely with academic achievement because even this is not possible if children do not know how to care for others and be cared for by others (Noddings, 1995c). In fact, while the survival of society is dependent upon people who are literate, numerate and able to cope with solving the problems of day-to-day life:

> our society does not need to make its children first in the world in mathematics and science. It needs to care for its children – to reduce violence, to respect honest work of every kind, to reward excellence at every level, to ensure a place for every child and emerging adult in the economic and social world, to produce people who can care competently for their own families and contribute effectively to their communities (Noddings, 1995a, p.365).

With breakdowns in traditional family structures, it is no longer the case that commonly-accepted values are passed from one generation to the next (Carr, 1997). Therefore the responsibility is falling more and more on schools to fulfil this role - and yet it continues to be difficult for them to do so, particularly with increasing pressures to achieve high test scores even in primary schools (Noddings, 1995a).

Table 1: Examples of values

Personal Values	• perseverance • responsibility • harmony in thought, word and deed • inner peace/tranquility/calmness • forgiveness • self-reliance • moral strength • patience/tolerance • enthusiasm for work • humility • keeping promises • honesty/truthfulness • ability to stay focused in volatile

	situations
Interpersonal Values (i.e. with peer group or intimate others)	• beneficence (avoidance of unnecessary harm and maximisation of good outcomes • respect/tolerance (acceptance of people as unique individuals) • sharing • justice and fairness (treating all individuals or groups equally according to their own merits) • regard for others • co-operation • consideration of others' needs • acknowledging/celebrating • others' achievements without jealousy
Community Values (i.e. with strangers, global others, natural world, non-human creatures)	• beneficence • respect • justice & fairness • conservation of energy and resources • service to humanity • charity • tolerance of others cultural beliefs • care for/protection of environment

Clearly, while time and curriculum constraints can make it difficult, if not impossible, to include education in human values as an additional topic in the curriculum, there are many opportunities to teach its principles through existing subjects and topics (Taplin, 1998). This has the added advantage that the schools do not have to abdicate in any way their responsibility to teach the academic skills but that they will be rethinking the ways in which they do this (Noddings, 1994). The purpose of this article is to suggest some ways in which mathematics teachers can incorporate values education into existing mathematics programmes. It is hoped that this article will be the stimulus for further discussion and sharing of ideas amongst teachers. Please note that links to particular values will be highlighted in italics.

Taplin (1998) has identified three ways in which values education can be integrated into the existing mathematics programme:

1. Educating for Human Values Through Approaches to Teaching Mathematics,
2. Using Mathematics as a Tool to Practise Human Values,
3. Teaching Human Values Through Examples of Great Mathematicians.

Some examples of ideas for each of these will be discussed in the following sections.

Educating For Human Values Through Approaches To Teaching Mathematics

Problem Solving

Traditionally, mathematics teaching has been mostly concerned with filling pupils' heads with rules and knowledge, to be remembered until the examination, and then forgotten by all but those few who need to use the knowledge in their work. But, more recently, educators have come to realise that mathematics teaching does not have to be like this. By re-thinking the way we teach mathematical topics, we can help students to develop the values of *common sense* and *discriminatory use of knowledge*, *arouse their interest in the subject to a level where it can become integrated with the whole being*, and help them to be able to *use their mathematics knowledge as a tool for meeting the challenges of life.*

Increasing numbers of individuals need to be able *to think for themselves in a constantly changing environment*, particularly as technology is making larger quantities of information easier to access and to manipulate. They also need to be able *to adapt to unfamiliar or unpredictable situations* more easily than people needed to in the past. Teaching mathematics encompasses skills and functions which are a part of everyday life, for example reading a map to find directions, understanding weather reports, understanding economic indicators, understanding loan repayments, or calculating whether the cheapest item is the best buy.

Presenting a problem and developing the skills needed to solve that problem is more motivational than teaching the skills without a context. It allows the students to see a reason for learning the mathematics, and hence to become more deeply involved in learning it. Teaching through problem solving can enhance logical reasoning, helping people to be able to decide what rule, if any, a situation

requires, or if necessary to develop their own rules in a situation where an existing rule cannot be applied directly.

Problem solving can allow the whole person to develop by experiencing the full range of emotions associated with various stages of the solution process.

There is no doubt that mathematics presents situation which really test *patience* and *perseverance*. There are many students who expect solutions to come to them quickly and easily and will give up rather than face negative emotions associated with trying the task. Furthermore, they are often not aware of when it is worthwhile to keep on exploring an idea and when it is appropriate to abandon it because it is leading in a wrong direction. They need to know when it is appropriate to use a particular approach to the task, and how to recover from making a wrong choice.

Co-operative Learning

The values of *unity, co-operation* and *mutual regard* are essential to a peaceful community, whether it be in the classroom or in society in general. Current research about teaching mathematics suggests students can come to a better understanding of many mathematics topics if they have the opportunity to work together in pairs or small groups. To do this successfully, teachers need also to teach their pupils the skills of *working with others in a truly co-operative situation.*

Using Mathematics As A Tool To Practise Human Values

There are many ways in which the use of mathematics can help to reinforce and apply important human values. This section describes some sample classroom activities that suggest how teachers can use topics in the current mathematics syllabus to facilitate the practise of human values, without having to introduce extra topics into the curriculum. Some examples include:

learning to conserve and protect the environment through, for example, monitoring the use of paper, or investigating the potential to recycle some materials (statistics, graphing);

creating *awareness of social issues* such as money management (problem solving, simple and compound interest, basic operations), problems such as

gambling (probability), and sharing food (measurement, estimation, calculations with whole numbers and fractions);

understanding our heritage and culture through learning more about the history of how mathematics developed, learning about different ways of thinking about mathematics in different cultures, and *appreciating the balance and beauty of mathematics.*

Mathematics can be used as a tool to explore social issues. The following examples of activities will show how we can encourage pupils to use it to develop an understanding of their *social obligations*, ways in which they can *conserve and protect the environment* and contribute towards *the welfare of others in society.*

Mathematics And Conserving The Environment

The following ideas have been taken from *Arithmetic Teacher* 41(1), September 1993, 27-29.

Mathematics Topics: Statistics, Graphing

Classroom Paper

Ask students to predict the number of pieces of paper they will use during the day. Keep a tally of the actual number used. Use graphs to record the numbers used over a week. Discuss the findings. Were they surprising? Do pupils think they are using too much paper? What are some ideas for saving paper? Implement some of these ideas, and collect further data for comparison. Have students examine and compare their graphs and discuss things they notice. Why might numbers vary from student to student? Why might more paper be used on some days than others? Has the campaign to reduce the use of paper been successful?

Mathematics Topics: Statistics, Graphing

Aluminium Cans

Conduct a survey amongst friends and family members to find out how many aluminium cans they use in a typical day. Use this information to calculate the average individual's can use in a year. Use the results as a basis for discussion about conservation of aluminium. Similar activities can be done with other materials, including grocery bags from supermarkets.

Mathematics Topic: Percentage, Practise of Arithmetic Skills

Managing Money as a Resource

For the secondary school: to teach skills of personal money management and develop mathematical skills:

Draw a bar chart showing how $1000 grows with compound interest at 14% over 20 years. What is the final balance?

Draw a pie chart showing your expected spending pattern on leaving school

Using Mathematics To Help Others, To Understand Humanity Better And Understand Our Heritage/Culture

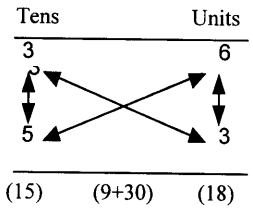
Barta (1995) has suggested that while traditionally it has been thought that mathematics and culture have nothing to do with each other, this is in fact not true:

> "Children seldom are taught that several of the ancient Greek mathematicians, Pythagoras and Thales (legendary founder of the Greek mathematics) for instance, travelled and studied in places such as India and Northern Africa where they acquired much of their mathematical knowledge. Students know little of the mathematical inventions or applications of such ancient non-European cultures as the Egyptians, the Babylonians, the Mayan, the Incas, to name but a few. They don't understand because they have not been taught that many cultures have contributed to the development of mathematics; cultures whose members were certainly intelligent, resourceful and creative....Mathematics is a compilation of progressive discoveries and inventions from cultures around the world during the course of history. Its history or ethnography has been a wonderful mosaic of cultural contributions." (Barta, 1995, p.13).

Nelson, Joseph and Williams (1993) give examples of selected mathematics topics, showing different approaches to these topics which have been developed in different cultures. One example they use is multiplication. Pupils can be shown some of these different methods, to *appreciate that there are many different ways of arriving at the same answer.*

Vedic Multiplication (India)

36 x 53



Multiply the numbers in the units column vertically (6 x 3 = 18).
Multiply the tens and units columns crosswise and add (i.e. 3 x 3 + 5 x 6 = 39).
Multiply the numbers in the tens column vertically (3 x 5 = 15).
Place value adjustments are made by "carrying over" the relevant numbers, so 15 39 18 becomes

15 39 8 i.e. 15 40 8, then 15 0 8, i.e. 1908.
1 4

from Nelson, Joseph and Williams (1993), p.107

Egyptian Multiplication

28 x 13

Choose one of these numbers (e.g. 28) as the multiplier and continue to multiply it by 2 until you reach a stage where the next number in the left-hand column would exceed the other number (i.e. 13). Find the numbers in the left-hand column which add up to 13 (shown with * below). Then find the total of their corresponding numbers in the right-hand column, to get the answer.

*1	28
2	56
*4	112
*8	224
1+4+8=13	28 + 112 + 224 = 364

from Nelson, Joseph and Williams (1993), p.98

Russian Multiplication

225 x 17

This method involves continually doubling one of the numbers (17) and halving the other (225) but leaving out any remainder. This process continues until the number that is being halved becomes 1. Any row with an even number in the left-hand column is then crossed out, and the remaining numbers in the right-hand column are added together to get the answer.

225	17
~~112~~	~~34~~
~~56~~	~~68~~
~~28~~	~~136~~
~~14~~	~~272~~
7	544
3	1088
1	2176
	3825

from Nelson, Joseph and Williams (1993), p.99

Appreciating The Beauty Of Mathematics

Naidu (1986) talked about the truth, power and beauty of mathematics (p.6):

> mathematics is a wonderful subject which has a great relevance in taming the mind, training the intellect, and purifying the vision through the awakening of intuition of the individual. Every mathematics teacher must make it his mission to unfold fully all the intellectual and intuitive facilities of the student by imparting the subject in a proper perspective so as to kindle *love* for the subject, make the student grasp *truth*, create intense *delight* in his heart by

unfolding the *power, beauty* and *social value* of the subject of mathematics.

One example of the way in which mathematics connects seemingly unrelated things is the sequence of Fibonacci numbers, discovered in the thirteenth century by Leonardo Fibonacci (Barnard, 1996).

Mathematics Topic: Number Patterns, Simple Algebra
Fibonacci Numbers

One way to begin a study of the Fibonacci sequence of numbers is to start with a pair of rabbits (one male, one female). Rabbits begin to produce young two months after their own birth. After the first two months, each pair produces a mixed pair (one male, one female) and continues to produce another mixed pair each month. Students can count the number of pairs born in each month, finding that the sequence will be 1,1,2,3,5,8,.... Soon they can find a way to predict subsequent terms in the series.

Barnard (1996) listed several examples of Fibonacci numbers in Nature: "Cutting a bell pepper crosswise reveals 3 chambers. An apple has a 5-point-star cross section, and a lemon has an 8-chambered cross section. A daisy almost always has 13, 21 or 34 petals. Sunflower seeds spiral out from the center with 21 spirals in one direction and 34 in another. The giant sunflower has 89 and 144 spirals, and the shopper sunflower has 144 and 233 spirals. Each set of spirals contains adjacent Fibonacci numbers." (p.1).

Students can be asked to find the ratios of successive Fibonacci numbers. This will give the golden ratio, which was the basis for the golden rectangle used in ancient Greek architecture to achieve perfect proportions in structures such as the Parthenon (Pappas, 1987). The golden rectangle is also evident in the proportions of the human body, as illustrated by Leonardo da Vinci (Pappas, 1987).

Garland (1987) pointed out that Fibonacci numbers and proportions appear in musical scales, and in the division of musical time in compositions. Fibonacci proportions have been found in compositions including Gregorian chants, Bach fugues, and Bartok sonatas. "It has been suggested that the Fibonacci numbers are

part of a natural harmony that not only looks good to the eye but sounds good to the ear" (p.34).

Teaching Human Values Through Examples Of Great Mathematicians

Voolich (1993) explained that sing biographies of mathematicians can successfully bring the human story into the mathematics class" (p.16). The following are two brief biographies of famous mathematicians who have *proclaimed the supremacy of morality and character...refraining from harming others, showing compassion, courage, sacrifices.* It is suggested that teachers can share these biographical excerpts with their pupils in conjunction with the regular study of the topics with which these and other famous mathematicians are associated.

Maria Agnesi (1718-1799) Italy
Example of Contribution to Mathematics: calculus

> "Maria was a child prodigy, but was also shy. She stayed at home, teaching the younger children and following her own studies. When her mother died after giving birth to many children, Maria took over the running of the household.
>
> At the age of twenty she started a ten year project, a book bringing together the work on calculus of Leibnitz and Newton titled Analytic Institutions. Sometimes she would have trouble with a problem. But her mind went on working even in her sleep; she would sleep-walk to her study and back to bed. In the morning, she would find the answer to the problem waiting on her desk. Her book made her famous; she was living proof of what she had argued at nine years old [that women had a right to study science].
>
> But Maria had other interests in her life apart from mathematics. She had always worked with the poor people in her area, and she had asked her father for separate rooms and turned them into a private hospital. She worked at the hospital (and another) until she died at the age of eighty-one.

Maria Agnesi wrote an important book on mathematics, as well as another unpublished book. She ran a household of over twenty people, and she worked for people who had not had her luck and opportunities. Each one of these things was remarkable, but she did them all."
(Lovitt and Clarke, 1992, p.560)

Rene Descartes, Born, March 31st, 1596 at La Haye, near Tours, France
Examples of Contribution to Mathematics:
analytic geometry; application of co-ordinate geometry to equations of curves

Descartes lived during a troubled time, when strong rulers and politicians took whatever they wanted from whomever they wanted, by force. It was also a time of "religious bigotry and intolerance which incubated further wars and made the dispassionate pursuit of science a highly hazardous enterprise"
(Bell, 1937, p.35). Added to this was a prevalence of plague and disease brought about by the lack of cleanliness and proper sanitation just as common amongst rich people as poor. Descartes overcame these hardships to succeed in his chosen field.

Because Descartes was an unhealthy child, his teacher allowed him to lie in bed for as long as he wanted to in the mornings. From this, Descartes learned of the value of quiet meditation whenever he needed to think, and continued to do this for the rest of his life. This was the time when his great mathematical and philosophical discoveries came to him. One famous quotation of Descartes' was that he preferred truth to beauty.

Descartes was not wealthy, but he was contented with what he had and felt that this was enough. He was moderate in his habits, and was very kind to others. While he often inflicted a Spartan way of living on himself, he never expected the rest of his household to live in the same way. He continued to help with the welfare of his servants long after they had left his service.
(Bell, 1937)

Conclusion

The ideas presented in this article suggest some ways in which the teaching of human values can be integrated into the existing mathematics programme without needing to add anything extra. Further ideas have been presented in a book written by the author (Taplin, 1988). As well as giving teaching ideas, the book summarises recent research and suggests some questions for action research or discussion that teachers can use in their own classrooms. For further information about the article or the book, please contact the author (mtaplin@ouhk.edu.hk).

References

Barnard, J. (1996). 'Those fascinating Fibonaccis!' *National Council of Teachers of Mathematics Student Math Notes*, January.

Barta, J. (1995). 'Reconnecting maths and culture in the classroom: ethnomathematics'. *Mathematics in School*, 24 (2),12-13 .

Bell, E.T.(1937). *Men of Mathematics* (Touchstone Edition, 1986). New York: Simon & Schuster.

Benn, R. & Fieldhouse, R. (1995). Adult education and learning for citizenship'. *Adults Learning*, 6, 10, 103-105.

Carbone, P. (1991).Perspectives on values education'. *Clearing House*, 64, 5, 290-292.

Carr, D. (1997). Educational values and values education: some recent work'. *British Journal of Sociology of Education*, 18, 1, 133-142.

Dror, Y. (1993). Community and activity dimensions: Essentials for the moral and values educator'. *Journal of Moral Education*, 22, 2, 125-137.

Garland, T. (1987). *Fascinating Fibonaccis: Mystery and Magic in Numbers.* Palo Alto, CA: Dale Seymour Publications.

Jennings, Bruce; Nelson, James Lindemann (1996). Values on campus'. *Liberal Education*, 82, 1, 26-31.

Lockwood, A. (1993). A letter to character educators'. *Educational Leadership*, 51,3,72-75.

Lovitt, C. & Clarke, D. (1992). *The Mathematics Curriculum and Teaching Program: Professional Development Package*, Carlton, Victoria: Curriculum Corporation.

Naidu, K. (1986). 'Value orientation to the teaching of mathematics'. *The Sai World Gazette*, 4,.5-6.

Nelson, D., Joseph, G. and Williams, J. (1993). *Multicultural Mathematics: Teaching Mathematics from a Global Perspective.* Oxford: Oxford University Press. ISBN 0-19-282241-1.

Noddings, N. (1991). Values by deliberation or default'. *Clearing House*, 64, 5, 320-322.

Noddings, N. (1994). The role of educators in combatting violence'. *Religious Education*,. 89, 4, 568-571.

Noddings, N. (1995a). Teaching themes of caring'. *Education Digest*, 61, 3, 24-28.

Noddings, N. (1995b). A morally defensible mission for schools in the 21st century'. *Phi Delta Kappan*, 76, 5,365-368.

Noddings, N. (1995c). Teaching themes of care'. *Phi Delta Kappan*, 76, 9, 675-679.

Pappas, T. (1987). *Mathematics Appreciation.* Can Carlos, CA: Math Aids/Math Products Plus.

Taplin, M. (1998). *Education in Human Values Through Mathematics: Mathematics Through Education in Human Values.* Hong Kong: Sathya Sai Baba Center of Hong Kong.

Voolich, E. (1993). 'Using biographies to 'humanize' the mathematics class'. *Arithmetic Teacher*, 41(1),16-19