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MOULDING POSITIVE CHARACTERS VIA INCULCATING VALUES IN MATHEMATICS TEACHING AND LEARNING

Lim, Chap Sam

School of Educational Studies
Unversiti Sains Malaysia

cslim@usm.my

Abstract

In this paper, I argue that it is pertinent to develop positive characters among all students as they are the future assets of a nation. A review of related literature shows that inculcating values and moulding character has been of great concern in the school mathematics curriculum of many countries. There are various categories of intrinsic values embedded in mathematics education. With careful and mindful integration into teaching and learning of mathematics, it is possible to inculcate positive values and thus produce positive characters of our future generation. Some suggestions on how to inculcate these values into mathematics teaching and learning at various school levels were discussed at the end of this paper.

Keyword: mathematics teaching and learning; moulding character; values in mathematics education

INTRODUCTION

Children are assets of a nation and some of them will be potential leaders of the country. The future of the country will depend very much on the quality of its human resources. In this fast changing digital society, it is difficult to foresee what kind of knowledge and skills would be needed by our children in the coming decades. Therefore, our children must be provided with generic knowledge and skills that would enable them to survive and succeed in the future global world. Besides knowledge and skills, more importantly, the goal of educating children should be to mould them with positive characters and values.

However, character is not something that can be formally taught or trained. Instead, children develop their character through observing and imitating people around them. Besides parents, teachers are the closest people that the children spend most of the time with in school. Naturally, teachers become the role models that will influence the children's character building. Hence, it is pertinent that teachers place high priority on inculcating values and building positive character of their students during the process of teaching and learning of any school subjects, such as mathematics.

MATHEMATICS CURRICULUM AND CHARACTER MOULDING

A review of related literature shows that inculcating values and moulding character has been of great concern in the mathematics curriculum of many countries, particularly in

South East Asia. For example, in the Malaysian School Mathematics Curriculum, inculcation of values was explicitly stated in the Integrated Curriculum for Secondary School mathematics syllabus as follows:

> "The intrinsic value of mathematics namely, thinking systematically, accurately, thoroughly, diligently and with confidence contributes to the moulding of character and of positive attitudes as these values are infused throughout the teaching-learning process. Sound moral values can be introduced naturally in context; however, this requires planning on the part of the teacher".
>
> <div align="right">(Malaysian Ministry of Education, 2003, p.2)</div>

The above citation recognised that mathematics as a learning subject possesses intrinsic values such as thinking systematically, accurately, thoroughly, diligently and confidence which are important to the moulding of positive character and attitudes of the students. These values, if plan carefully by the teachers, they can be inculcated naturally throughout the process of teaching and learning mathematics.

Similarly, in the Singaporean School Mathematics Curriculum, two of the stated main aims were: "(i) develop positive attitudes towards mathematics including confidence, enjoyment and perseverance; and (ii) appreciate the power and structure of mathematics, including patterns and relationships, and to enhance their intellectual curiosity" (Singapore Ministry of Education, 2000, p.9). Although the word "value" was not spelled out explicitly in these objectives, words such as appreciation, interest, confidence and perseverance are values to be inculcated in teaching. In particular, the above objectives highlighted the power and structure of mathematics – patterns and relationship that need to be emphasized in teaching so as to enhance students' intellectual curiosity. Students who are intellectually curious are more likely to be creative and innovative in their thinking. Creativity and innovation are productive characters that we would like our future generation to have so as to ensure national development. Furthermore, as reported in the OECD (2011) that the latest Singaporean Curriculum 2015 is "re-emphasising that education must be rooted in values" (p.163). It aims to strike a balance between content, skill and character development to achieve a more holistic education that will produce a "whole child".

It is thus not surprising to read that in the Indonesian National Goal of education (2003) that,

> Jabaran UUD 1945 tentang pendidikan dituangkan dalam Undang-Undang No. 20, Tahun 2003. Pasal 3 menyebutkan, "Pendidikan nasional berfungsi mengembangkan kemampuan dan membentuk watak serta peradaban bangsa yang bermartabat dalam rangka mencerdaskan kehidupan bangsa, bertujuan untuk berkembangnya potensi peserta didik agar menjadi manusia yang beriman dan bertakwa kepada Tuhan Yang Maha Esa, berakhlak mulia, sehat, berilmu, cakap, kreatif, mandiri, dan menjadi warga negara yang demokratis serta bertanggung jawab."
>
> <div align="center">http://www.putra-putri-indonesia.com/tujuan-pendidikan-nasional.html</div>

It is generally hoped that national education will provide a gateway to develop a student's potentials so as to become a wholesome man who is faithful and devoted to God, noble, healthy, knowledgeable, skilled, creative, and independent as well as a responsible citizen in a democratic country. Thus, the values of creative, independent, noble and responsible were again explicitly spelled out in the national goal of education in Indonesia. The more

urgent issue now is how to integrate values in mathematics teaching so as to inculcate or mould positive characters of our potential generation. Before that, let us discuss briefly values in mathematics education that have been researched in mathematics education literature.

VALUES IN MATHEMATICS TEACHING AND LEARNING

According to Bishop (1988), values in mathematics education can be of three basic kinds:

1. **Mathematical values**: values which have developed as the subject has developed within the particular culture.
2. **General educational values**: values associated with the norms of the particular culture, of the particular society, and of the particular educational institution.
3. **Mathematics educational values**: values embedded in the curriculum, textbooks, classroom practices, etc. as a result of the other sets of values.

Meanwhile, based on literature and analysis of their data collected, Lim and Ernest (1997) revised the list of values in mathematics teaching and learning and classify them in the following three categories:

a. **Epistemological values** - values involved with the acquisition, assessment and characteristics of mathematical knowledge and in epistemological aspects of the processes of teaching and learning mathematics, such as accuracy, systematicity and rationality.
b. **Social and cultural values**-- values which favour or support the social group or society and which concern the individual's duty to society as related to mathematics education. Examples from this category are co-operation, justice and appreciation of the beauty of mathematics.
c. **Personal values** - values affecting the individual as a learner and as a person, such as patience, confidence and creativity.

(p.39)

Clearly, we noticed that many of the above listed values coincide with the goals of mathematics education in many of the countries as discussed earlier. In particular, social and cultural values such as co-operation, justice and honesty while personal values such as confidence, creativity, patience and responsibility are desirable values and characters that we would like our future citizens to possess. Consequently, we may argue that it is possible to mould positive character of our future generation through the teaching and learning of mathematics since mathematics education itself is embedded with intrinsic values.

SUGGESTIONS TO INCULCATE VALUES IN MATHEMATICS TEACHING AND LEARNING

There are various ways of inculcating values in mathematics teaching and learning so as to promote positive character. It can be done either implicitly or explicitly; during the process of teaching or discussion; using individual or group activities; at various levels from pre-school to tertiary level. The following discussion hopes to exemplify some of the possible strategies.

Pre-school level: the value of <u>systematic</u> and <u>organized</u> through the concept of classification

At pre-school level, pupils are taught to compare the similarities and differences of two objects, and then classify them according to shape, size or colour. Classification is one of the most important basic mathematical concepts that a student has to learn. Imagine a library without classification or a supermarket with no classification? What a mess it will be? By classifying things (such as living things and non-living things); objects (by shape

and size); data (quantitative and qualitative), we learn to organize our life in a more systematic way. Therefore, as early as pre-school level, pupils should be trained to use classification to organize their things such as shoes and books. For example, they should be encouraged to place their shoes on the shoe rack, books on the shelf etc.

Primary school level: the value of <u>uniformity and universality</u> through the concept of <u>standard measurement</u>

Measurement is one of the basic mathematical concepts in primary school that is very important and useful in daily life. To make students aware of the importance of standard unit in measurement, at the beginning of the topic, pupils could be asked to measure the length of a rope using non-standard unit such as their own foot or hand. Then the students can be challenged with questions such as "Why does the same rope have different measurement values when using different students' foot?" The discussion can then be led to the importance of using standard unit. The function of using standard measure is for uniformity and universality. Everyone must use the same unit of measure so that we can compare the quantities no matter where we are in the world. This is important when we are dealing with selling and buying things. Using standard unit also makes it convenience for comparison and explaining scientific results and findings. Imagine if different scientists using different units to measure something, how are they going to communicate their findings? If we want to order a dress from another place, then we have to tell our body measurement in the same standard unit, or else the dress that we order may not suit our size. Therefore in mathematics, we talk about standard unit so as to inculcate the value of uniformity and universality that help to communicate with others in a fair manner.

Primary school level: develop <u>confidence</u> by learning through mistakes

Mathematics learning always involves solving problems. When solving mathematical problems, it is very likely to make mistakes. If a teacher can make use of the students' mistakes to discuss in class, this will not only enhance the students' understanding but also boost up their confidence. This is particularly useful for weak pupils. Instead of scolding or punishing a student who make mistakes right away, it will be more effective if the student is asked to show his mistakes in front of the class, and then the teacher could guide or patiently lead him/her to understand his/her own mistakes and to solve the problem by himself/herself in the end. The following episode illustrates this scenario: T (Teacher) and S (Student).

S: Calculate it again.
S：再算多一次。

T: Did you know why teacher likes him so much?
S: He takes it seriously
T: Why he takes it seriously?
S: Because just now he did wrongly, now he calculates it again.
T: Yes, Look at him. Just now he did wrongly. Yes or no?
S: Yes.

T: Teacher said that you must be careful. You see just now after he finished the calculation, I thought he wants to go back, but he didn't. What else has he done?
S: calculate it again.
T: Yes, he calculates it again seriously. This is the correct learning (attitude).
T: So you have to help (him) calculate. You see he listened and understood instantly. Just now he did wrong once, now he do it again seriously. Very good, everyone must learn from him.

With tactful and encouraging tones, we observed that the teacher has not only successfully guided the weak student to correct his own mistakes, but also has boost up his confidence as he was praised for his serious attitude in making his correction. Other pupils in the class also have learnt from this case that it is alright to make mistakes but more importantly to learn through mistakes.

   Secondary school level: the value of <u>responsibility, rationality</u> through the learning of <u>statistics</u>
Statistics is an important area of mathematics which is concerned with collection, analysis and interpretation of data, as well as the representation and communication of the results based on the anlysis of data. Statistics is getting very important in nowadays. It helps to make quantitative reasoning which is necessary for making advances in sciences, particularly medicine and genetics, as well as for making important decision in policy and business. However, statistics can lie. Therefore it is pertinent for teacher to alert the students about the possible caveat of interpreting statistical data. As in the following worksheet example (see Figure 1). We can ask students to interprete the data in different ways as suggested. We can then ask the students to discuss what are the implications of the different interpretation of data.

We should lead the students to realise that statistical data can be manipulated to suit certain agenda. This is particularly so for political advantage or advertisement gain. Therefore the value of responsibility and rationality are important here. As a researcher or a person who supply the interpretation of data, we are responsible in giving a true picture or valid results. This concerns our responsibility and integrity. Meanwhile, as a consumer of information, we must learn to be cautious and rationalize the results given, whether these results really represent the real data or information obtained.

Statistics Worksheet

Whose child is top?

Three Singaporean parents were comparing the results of their children who were in the same kindergarten. The following table gives the marks obtained by the children in the five graded subjects:

Parent	English	Chinese	Math	Music	PE
Ambitious	75	60	55	65	75
Kiasu	70	59	70	77	60
Pushy	60	55	94	58	65

1. Normally, one would total up the marks and take the average for the 5 subjects. Using this procedure, determine whose child comes up top.

2. Mrs. Ambitious said that ranking should be used. As her child was top in 3 subjects, surely he should be the top student. For each subject, rank the children 1, 2 and 3 and then add up the ranks. Determine if Mrs. Ambitious' son is the child with the lowest (best) ranking. Use the table below.

Parent	English	Chinese	Math	Music	PE	Rank Total
Ambitious						
Kiasu						
Pushy						

3. However, English, Chinese and Maths are more "important" as they are crucial subjects in Primary 1. Should they be given double weightage? Copy the table below but give the 3 subjects double weightage (compute on maximum of 200 marks). Then add up the total for each child. Who is top now?

Parent	English	Chinese	Math	Music	PE	Total
Ambitious						
Kiasu						
Pushy						

Moral: Statistics can be manipulated to tell different stories.

This worksheet was designed by Lim Suat Khoh.

Figure 1

Secondary school level: the value of <u>respect</u> and <u>rule-binding</u> through the concept of <u>Set</u>

Extending the concept of classification we have the concept of *set*. A set is defined as a group or collection of things that belong together or resemble one another or are usually found together. In mathematical term, a set is defined as a collection of well ***defined*** and distinct objects. Instead of just defining the meaning of set and explain set theory, pupils

should be provoked to think, "Why is it that a set has to be well defined?" "What happened if it is not?" Here, the meaning of "well defined" is that there is a definite method to determine if an object belongs to the set. In other words, there are certain rules and regulations, or criteria that decide whether an object belongs to a specific set or group. For example, "2, 4, 6, 8 " are even numbers because an even number is defined as the number that is divisible by 2. But "5, 7, 9" are not even numbers because they are not divisible by 2. Likewise, for you to be qualified as a student of University X, you have to fulfil certain criteria. If a set is not well defined which means there are no clear cut criteria, then the consequence could be messy as no one knows whether the object should belong to which group.

Nevertheless, in reality, not everything can have a clear cut division. Hence, in mathematics, there is the introduction of "universal set" to set the boundary or limitations to the problem posed. For example, the answer to a given mathematical equation will likely be different when given different universal sets, as in the following example:

Find the solution to the following equation: $(x+1)(x-2)(x-3) = 0$ if x belongs to the universal set of:

a) real numbers

b) even numbers

c) natural numbers

The solutions would be

a) $\{-1, 2, 3\}$

b) $\{2\}$

c) $\{2, 3\}$

(The above example is cited from Swadener & Soedjadi, 1988, p.201)

When discussing the above example with students, we can highlight the importance of defining the universal set clearly and the dependence of the solution on the universal set. Failing to consider this might lead to misconception, invalid or incorrect solution. Extending this kind of discussion to daily life situations, the teacher can encourage students to be aware of the rules and regulations set by an authority or country. To be law abiding citizens, we must always be aware of the environment or community that we are situated, respect the laws and limits set up to ensure harmony and safety of a nation. For example, traffic rules, age limit for getting a car license etc. What would happen to a country or an organization if there are no laws or regulations to follow?

Secondary school level: the value of <u>flexibility</u> through the learning of <u>trigonometry</u>

Trigonometry appears to be a meaningless topic as its problem focus on the properties of a triangle. Given the values of two angles we can find the value of the third angle. In certain cases, given two sides and one angle, we can find the values of the other one side and two angles. Applying Pythagoras theorem onto a right angle triangle, we can find the third side if given the other two sides.
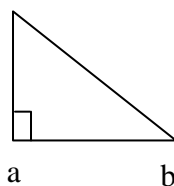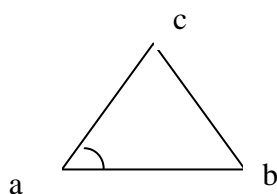
Based on the properties of a triangle, parallel line and circle, we can solve many unknown even though only a few variables are known. For example:
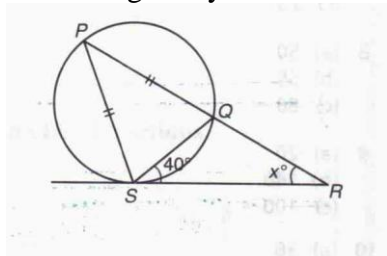

Figure 2

In Figure 2, if given SR is a tangent to the circle and PQR is a straight line, we will able to find the value the angle x, as well as angle SPQ, angle PQS, angle PSQ etc.

This is one of the power of learning trigonometry and geometry, it trains the students to think flexibly. Students must be trained to see things from different angles or perspectives. Based on what they have known, they should be able to solve a problem. This can be applied to daily life situation. When challenged with problems, we must be flexible in our thinking and approach, so as to solve the problems on hand. We should not just solve a problem in a linear manner or using vertical thinking, but better be flexible and using various kinds of thinking.

Secondary school level: the value of openness through problem solving

Even though most of the school mathematics problems are often considered to have only one answer or an absolute truth but this is not true for real life problems. Even mathematicians have to make numerous attempts and using multiple perspectives to solve a mathematical problem. Therefore it is important that when teaching problem solving in mathematics, students should be encouraged, not just to solve routine problems but also to solve non-routine problems or open-problems that can be solved in multiple ways or have multiple solutions. For example, students should be given a problem, then encouraged to solve it in different ways. Most importantly, they must be able to explain their methods used and the reason for their choice. In this way, they will learn to be logical and analytical. Every student or every group of students should then be given the opportunity to present their solution or method. All the other students need to listen attentively to their peers. They can argue or debate the validity of the solution or method but justified with valid reasons. In this way, the value of openness and respect for others can be integrated.

Tertiary level: the value of <u>responsible freedom</u> and <u>respect</u> each other, through <u>mathematical convention</u>

Mathematical convention is an agreement about a fact, a symbol, a name/notation or a way of doing things that mathematicians (generally all over the world) have made. For example, the most common numerical symbols: 0,1,2,3,4… are a world-wide convention that has been adopted from pre-school level through life (Swadener & Soedjadi, 1988). Students can be provoked to ask why must we count from 1 to 2 to 3 to 4 to 5 to,…9? Can we use another symbol to represent "1"?

Indeed, almost all mathematical symbols and notations are conventional. Why must we use the symbol "÷" for division and "+" for addition? There is no particular mathematical reason for these conventions. However, adopting these conventions provide a lot of convenience for the users to communicate with each other. Imagine the notation of "30! (factorial)" which represents 30x29x28x…x1 allows us to write its value in a such a

concise manner. Yet, if we are not familiar with the notation of "!" we might read "30!" as " THIRTY!! (Exclamation mark)".

Follow the order of operation, to compute 2 + 4 x 5, we have to carry out multiplication (4 x 5) before addition is also a mathematical convention. There is no specific reason why we must do so. As shown in Figure 1, we can have the freedom to compute these values in any order, but then contradiction will occur if we do so as the resulted answer will be different. Without respecting the convention, we will not be able to communicate with others.

2 + 4x5	2 + 4x5	2 + 4x5
= 6 x 5	= 2 + 20	=2 x5 + 4
=30	= 22	= 10 + 4 = 14

Figure 3

Therefore, getting students to realise that many mathematical symbols and order of operation are actually mathematical convention. Students must be made aware that these are social agreement that everyone must adhere so as to avoid misunderstanding or mis-communication. Even though we have the freedom to define any mathematical object as we like, but once we have reached an agreement, we are responsible to respect it fully.

Getting students to discuss the importance of respecting mathematical convention can lead to inculcating the values of responsible freedom and respect. In the mathematical world, mathematicians are given the freedom to define new terminologies in their own ways, but they are expected to respect the existing agreement or mathematical convention. Likewise, students must be encouraged to recognise and respect the social norms and social agreements (such as laws, rules and regulations) so as to ensure social discipline and social freedom.

CONCLUSION

Teaching and learning of mathematics are cultural activities and thus are value-laden, and not really value-free. There are various categories of values in mathematics education. With careful and mindful integration into teaching and learning of mathematics, it is possible to inculcate positive values and thus produce positive characters of our future generation. In this paper, I have attempted to discuss the possibilities of integrating values into mathematics teaching and also given some suggestions on how to inculcate these values. I fully acknowledge that inculcating values in teaching and learning of mathematics is not an easy endeavour. It takes a long time and enormous efforts of the teacher to prepare a good lesson that can fulfil this goal. Sometimes what is planned might not be what is implemented. Besides time constraint, cultural beliefs and school culture could also impeach the way teaching can be done. Albeit these issues and challenges, I hope very much that what we have discussed here might generate more discussions and thoughts among teachers and educators, and thus benefited our students in the long run, as well as fulfilling the goals of education in general.

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