

TEACHER'S INFLUENCE ON ADULT'S IMAGES OF MATHEMATICS : IMPLICATIONS FOR MATHEMATICS TEACHER EDUCATION

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Abstrak Kertas kerja membincangkan sebahagian daripada hasil dapatan satu kajian penyelidikan yang telah dijalankan untuk mengenalpasti punca-punca pembentukan imej matematik di kalangan orang dewasa. Analisis data kualitatif (sejumlah 62 temubual) telah mencadangkan bahawa guru matematik adalah faktor utama yang mempengaruhi imej matematik orang dewasa, terutamanya dari segi kegemaran matematik. Berasaskan kepada sorotan kajian yang berkaitan dan dapatan kajian ini, beberapa implikasi dan cadangan untuk pendidikan matematik telah dibincangkan dan dibentangkan.

INTRODUCTION

Perhaps it is of no one's surprise that teachers exert influence on students' learning. In any formal education, there is always a teacher. Even at this era of information technology, we still need at least a tutor to assist teaching for some courses that use distance learning through Internet or other technologies. Indeed, how a teacher teaches will certainly influence to some extent how a student learns. However, do teachers exert the same influence on all subjects? To what extent can a teacher influence a student's learning of subjects, such as mathematics? Does this influence persist to students' adulthood? If it does, what are the possible implications to mathematics teacher education?

With these questions in mind, this paper is written with the following three aims:

1. to review literatures that relate teachers' influence on students' learning of mathematics ;
2. to highlight some findings of a research study that relate teachers' influence on adult's images of mathematics;
3. to discuss the possible implications for mathematics teacher education based on the literature and findings of the study.

TEACHERS' INFLUENCE ON STUDENTS' LEARNING OF MATHEMATICS

The significant role of teacher in learning is indisputable. As noted by the NCTM Curriculum and Evaluation Standard (1989) that,

Teachers implicitly provide information and structure experience that form the basis of students' beliefs about mathematics. These beliefs exert a powerful influence students' evaluation of their own ability, on their willingness to engage in mathematical tasks, and on their ultimate mathematical disposition. (p.233)

Similarly in the Cockcroft report (Department of Education and Science, 1982), citing from the Royal Society (1976) stated that,

...mathematics is especially vulnerable to weak teaching. 'there is no area of knowledge where a teacher has more influence over the attitudes as well as the understanding of his pupils, than he does in mathematics. During his professional life, a teacher of mathematics may influence for good or ill the attitudes to mathematics of several thousand young people, and decisively affect many of their career choices. It is therefore necessary that mathematics should not only be taught to all pupils, but well taught. All pupils should have the opportunity of studying in the accompany of enthusiastic and well qualified mathematics teachers'. (p.188)

The above two quotes clearly recognise the importance of mathematics teachers in students' learning of mathematics. Both point to the influence of teachers in terms of their beliefs and teaching approaches. However, what have the studies in mathematics education to say about the influence of mathematics teachers then? A review of related literatures have shown that there are at least three aspects that mathematics teachers could exert influence on their students' learning:

Teacher's Beliefs And Images Of Mathematics

There is an increased concern about how teachers' images of mathematics might influence their students' (see Brown, 1992) images of mathematics. Several studies have taken into account how the values, belief and preference of teachers might influence the values and images of mathematics of their students (see Bishop, 1996; Lin & Chin, 1998; Leu, 1998). Fennema and Peterson (1985) propòse that teacher might act as an external influence on both students' internal motivational beliefs and on students' participation in classroom activities.

Brown (1992) sets up to examine the influence of teachers on children's images of mathematics. She observed and interviewed four mathematics teachers and six of each of their pupils. She used a qualitative approach of 'story telling' and 'critical incidents' to probe for their images of mathematics. Her findings indicate that:

Teacher A through challenging the pupils leaves with them an images of mathematics as initially hard but easy when it's sort out.

Teacher B through using the structure of the SMP 11-16 individualised learning booklets leaves with the pupils an images of mathematics as a set of titles from their booklets.

Teacher C sees mathematics as a framework of ideas which all link with each other and leaves with the pupils an images of mathematics based on using and applying it.

Teacher D and the pupils have a common images of mathematics as enjoyable. (p.31)

Thus, her results imply that different teachers with different teaching approaches will result in different images of mathematics for their pupils.

Teachers' Attribution About Students' Success Or Failure In Mathematics

Besides teachers' beliefs and teachers' images of mathematics, there are also some studies (Fennema et al., 1990) suggest that teacher's attributions about students' success or failure in mathematics could have influenced students' own attribution and consequently their achievement in mathematics. Fennema and colleagues (1990) attempt to determine whether teachers' beliefs and attribution differ between boys and girls' success or failure in mathematics. Thirty-eight first grade female teachers from 24 schools in United States were interviewed. They were asked to name two boys and two girls who were the most successful mathematics students in her class and then two boys and two girls who were the least successful in her mathematics class. She was then asked to choose the reasons for their success or failure. Seven attribution categories were given, namely student's ability, effort, intrinsic motivation, luck, easiness of the task, teacher helped and others helped (such as parents or peers). Their findings indicated that the teachers attributed differently about boys and girls' success and failure in mathematics. They perceived boys as being their best students and attributed 'ability' as reasons for successes and failure for boys but 'effort' for girls. Consequently, this difference in teacher's attributions for girls is widely believed to have a negative impact on achievement because girls might be led to perceive boys as having mathematical ability while they don't.

Mathematics Teachers' Personality And Teaching Approaches

Another argument is that teacher's influence is more often implicit in a student's mathematics experience learning in school. Most students when asked to recall their mathematics learning in school often remember their mathematics teachers in relation to their personality or their methods of teaching. There is some research evidence on this.

Using a narrative inquiry, McSheffrey (1992) examines the underlying reasons that lead to women's avoidance of mathematics. He studies seven women and 15 eight-grade girls, using narrative-based tools such as letters, stories and interviews. His study shows that teachers were the focus of the stories told by most of the participants. These participants recounted their feelings in the mathematics classroom affected by their teachers and they ranked their teachers who can make connections to real life situations to be the best mathematics teachers.

So far, most of the studies discussed above have focused on students (except study by McSheffrey, 1992). However, to what extent have the adults perceived their mathematics teachers to influence their images of mathematics and learning of mathematics. Therefore, more systematic studies are needed to explore the influence of mathematics teachers as related to this aspect.

THE STUDY ON ADULTS' IMAGES OF MATHEMATICS (LIM, 1999)

As part of a research study (see Lim, 1999) that aimed to explore adults' images of mathematics, I also looked into the possible factors of influence of their images. Findings of the study have shown that mathematics teachers were the most quoted factor of influence for these adults' images of mathematics (nearly 60%). Before highlight some findings of the study, I shall first briefly describe the method and respondents of the study.

Methods

Interpretative approaches employing both quantitative methods [in the form of a questionnaire in stage one] and qualitative method [in the form of semi-structured interviews by telephone in stage two] were used for data collection. The questionnaire consists of two open-ended questions and nine structured questions. The open-ended question asked for respondents' images of mathematics and that of learning mathematics while the nine structured questions elicited responses on the attitudes, beliefs and images of mathematician of the respondents.

The semi-structured interview which consists of four sections, aims to probe (i) reasons for liking or disliking mathematics; (ii) mathematics learning experiences in school; (iii) change of view after leaving school and (iv) other self-reported possible factors of influence on their images of mathematics. These telephone interviews lasted from 4 to 30 minutes, with an average of 12 minutes per interview. All interviews were transcribed and analysed.

Respondents

548 adults (aged 17 years old and above) responded to the questionnaires and 62 of them were interviewed in the follow-up telephone interview. These respondents came from four social classes (by occupation) subgroups: professionals, managerial and technical, skilled and unskilled workers, as well as teachers and students (both mathematics and non-mathematics specialists). All respondents are British public whom I met on the streets, in campus or contacted through friends.

Some Findings

For this paper, only findings that relate teachers' influence to adults' images of mathematics will be highlighted and discussed. These findings are mainly based on the analysis of the qualitative data (i.e. the interview transcripts). Besides probing for the respondent's reason for liking or disliking mathematics and their mathematics learning experiences in school, I also asked the respondents to reflect on whether their images or views about mathematics had changed from their school years to the present. This second set of questions was aimed to explore the possible factors of influence on the respondents' images of mathematics. Some factors that emerged from the data were mathematics teachers, parents, peers, mass media, social perceptions and valuations of mathematics.

Among the various factors quoted by the interview sample, mathematics teachers seem to be the most common factor that influences their liking and views of mathematics in school. It was quoted by nearly 60% of the respondents. For comparison purposes, I have divided the respondents into two major groups based on their reported liking of mathematics:

- (i) those who claimed to like mathematics and
- (ii) those who claimed to dislike mathematics.

I have found this division useful as it helps to highlight findings of the study and relate the influence of teacher to liking of mathematics, which indirectly reflect their images of mathematics. Therefore, in the following discussion, I shall discuss the finding with respect to a comparison of these two groups.

Among the 36 respondents who claimed to like mathematics, five stressed that their images of mathematics were 'definitely' influenced by their mathematics teachers. 12 of them mentioned that their mathematics teachers had a great deal of influence on their liking or view of the subject, while only two denied any formative influence emanating from their mathematics teachers. On the other hand, for those who claimed to dislike mathematics, half of them (13 out of 26 of this group) felt that their mathematics teachers have a lot of influence on their disliking and overall attitudes towards mathematics.

Although the number of interviewees (n=62) may be too small to make much generalisable claims, these data reflected the importance of teacher factor in adults' images of mathematics. In particular, considering that the influence of mathematics teachers was not asked directly by the researcher, but it was elicited by these respondents themselves in response to the question on their experience of mathematics learning and/or their change of view of mathematics over the years. Further analysis of the interview transcripts has resulted in some interesting findings.

Table 1 summarises and compares the different characteristics of mathematics teachers of the two groups. The readers may notice that the list of characteristics prioritises on three aspects: (i) teachers' teaching approaches; (ii) teachers' personality and (iii) teachers' rapport with students. In fact, all the three aspects were emerged in both groups' conversation albeit with different emphasis.

Table 1: A comparison of characteristics of mathematics teachers for those who claimed to like and those who claimed to dislike mathematics

Characteristics of mathematics teacher of those who claimed to like mathematics	Characteristics of mathematics teacher of those who claimed to dislike mathematics
<ul style="list-style-type: none"> ◆ explain well ◆ make learning interesting and enjoyable ◆ are inspiring and encouraging ◆ have a lot of patience ◆ give individual attention or time to pupils ◆ get along well with pupils 	<ul style="list-style-type: none"> ● give poor explanation ● have authoritarian or teacher-centred teaching style ● are discouraging or humiliating ● are lack of patience ● give more time to the clever ones ● do not get along well with pupils

SOME EXEMPLAR CASES

To illuminate further adults' images of mathematics and their possible influence from their teachers, I present here a few cases that exemplify the possible influence or relationship. I acknowledge that it was not possible for me to select any typical cases from my sample. I have chosen the following five cases with the aim of maximising the comparisons and contrasting the different cases.

Case 1: R328

Profile: *A surveyor *likes mathematics
* Age between 31-50 years old * Male

R328 gave his reason for liking mathematics as the fact that mathematics is a practical tool for him. He needs to use quite a lot of calculations such as the basic calculation of volumes, areas and other measurement in his daily work. As a result, his image of mathematics is "calculating". He viewed mathematics as mainly calculation of numbers and figures. He found learning mathematics "fun and interesting". He particularly liked to learn algebra because "it can be quite difficult to learn and so I quite enjoy that sort of thing, really" (text-unit 19). Like many others, he also perceived certain part of mathematics as 'difficult' but again he took this difficulty to make up the challenges that he enjoyed the most.

He did not enjoy his primary school mathematics very much because he found it difficult to grasp the concepts as compared to the other subjects that he had in school. In fact, his interest in mathematics changed greatly when he met with an encouraging mathematics teacher at his upper secondary school. He confessed that, "one of our teachers that we had years ago, who took us for mathematics was very good at it (mathematics). So, I mean, for you to pick up fairly easily. It might have affected me really" (text-unit 27). He described his mathematics teacher's teaching as "he got the point over special, probably" (text-unit 33). What he emphasised was that his mathematics teacher explained well and also in an interesting way, and consequently he found mathematics easy to understand.

Case 2: R133

Profile: *A primary mathematics student teacher *likes mathematics
* Age between 21-30 years old *female

R133 expressed a strong liking of mathematics because she "can do it" and also she "can working things out" (text-unit 3). She found mathematics useful in everyday life. She also enjoyed the beauty of mathematics and the abstract aspect of mathematics such as mathematical theories and mathematical proofs. In her view, mathematics is "numbers, science and shape and also more than we think" while the learning of mathematics is like "understanding how things work in the world, nature and industry". She emphasised both the practical application and the philosophical aspect of mathematics in her explanation.

When she was at primary school, she never wanted to do mathematics because she never fully understood it. Suddenly at year 6, she found mathematics, "...not that difficult, I can do it and I can understand. And I suddenly shot up..." (text-unit 22). She attributed this change to her mathematics teachers whom she still could remember very well that, "...he explained it in the way that I understood" (text-unit 24). However, her mathematics experience was not always smooth. When she was at GCSE level, she met a mathematics teacher, whom she described as, "I just found his explanations really unhelpful. You know, he kind of showed me that he could do it but he didn't show me how I could learn to do it" (text-unit 30). Later at A-level, she found mathematics became more difficult but she was very happy with her mathematics teacher. This was because she "could go to him any time and he would stop what he was doing. He helped me to understand my maths" (text-unit 31). Thus, she stressed the importance of her

mathematics teachers' explanations and encouragement, as an explanation for her success in mathematics.

Moreover, it was these positive experiences that she would like to carry over to her future mathematics teaching. She promised that,

"he [her mathematics teacher] is the kind of person that I think about when I am teaching. What kind of teacher do I want to be? I want to be able to... when I see a pupil say, 'Miss, could I have some extra help?' I would stop, no matter what I was doing and say, 'yes, that was what I am here for and you don't worry I will help you'..." (text-unit 32).

Case 3: R370

Profile: *A mathematics student

*likes mathematics

* Age between 17-20 years old

*male

R370 claimed to like mathematics because he liked the challenge of solving mathematical problems. He felt depressed sometimes when he couldn't solve a problem. However, he felt challenged and rewarded when he managed to solve it. Hence, he wrote, "mathematics is problem solving" as his images of mathematics in the questionnaire. He explained that, "yes, it seems most of the time, it's quite a lot of solving and using certain formulae and ideas" (text-unit 9). Consequently, his images of learning mathematics is like "riding a bike, it needs practice". To him, learning mathematics is like learning a skill, one needs a lot of drill and practice, it must be used in many different contexts and applied in various kinds of problems.

He experienced both good and bad moments in mathematics learning during different stages his schooling. As he illustrated,

I went through stages where we were doing a topic and I just couldn't get a hang of it and I just got down and down. But most of the time, I just went to my teacher or I just struggled out of it. And all the time, eventually I just got it and understand about it. So it sorts of good and bad, it helps me to see that at the end of the day, you will get it. And it is quite rewarding after that. (text-unit 25)

In fact, his interest in mathematics increased when he started his A-level mathematics. He attributed his growing fascination in mathematics to his A-level mathematics teacher. As he said

"you know, three years ago, I won't have had a lot of fascination about mathematics and I won't have considered taking it up at A-level..." (text-unit 29). But then "I think my A-level course is really a good course and the teaching of my teacher is really good and I got influenced by it. And I got good results and that kind of encouraged me a bit" (text-unit 31).

Obviously the above three cases exemplified the significant influence of mathematics teacher on his students, especially in fostering a student's interest in mathematics.

Case 4: R218

Profile: *A mental health professional
* Age 31-50 years old

*dislikes mathematics
* female

R218 claims to dislike mathematics because she found mathematical concepts difficult to understand and also irrelevant to her life. She can handle and understand the relevance of day-to-day mathematics such as the calculation of household budget. However,

"when it gets away from reality, from my reality, it doesn't have any direct relevance to me, I have no interest." (text-unit 3)

and she found these concepts difficult to understand too Her images of mathematics was "frightening and cold" because these were her feelings when she recalled her day at school. She blamed that on her mathematics teachers because

"mathematics was never taught to us, you know, in a thoughtful way. It was always difficult" (text-unit 7).

She stressed that

"I think I hardly have any respect for my mathematics teachers because I don't think they were teaching me in a way that I could understand, why were they telling me this, what relevance does it have. What is so important about this. There were a lot of theories that you have to learn but you could not see why you have to know it" (text-unit 9).

She believed that her mathematics teachers did not explain well and she could not see the relevance of learning mathematics at all. As a result, she developed her images of learning mathematics as "climbing a steep hill". She found learning mathematics "was all suffering and so little enjoyment" (text-unit 15). Even though sometimes she found satisfaction when she found the right answer. Most of the time she found she was just following the formula without any deep understanding of what it is all about.

In brief, Case 4 shows an exemplar case of someone who dislikes mathematics because she cannot see the relevance of mathematics in her daily life. She found mathematics difficult but she did not take it as challenges. Instead, she puts her blame to her mathematics teacher for not explaining well and not giving enough encouragement to her. Indirectly, case 4 implies the important role of mathematics teacher in a student's view of mathematics

Case 5: R284

Profile: *A primary non-mathematics student teacher
* Age between 21-30 years old *female

*dislikes mathematics

R284 disliked mathematics because she was put off by her mathematics teacher in school. She felt very confused and could not understand how and why she got that answer. At primary school, she enjoyed her mathematics lessons because "it was more fun and more flexible" (text-unit 7). When she entered secondary school, she found mathematics boring and irrelevant as she explained that,

"I never understand them and as I need to do them, I always said, 'Oh! No' " (text-unit 9). As a result, she sees mathematics as "boring because you follow the same pattern all the time" while her images of learning mathematics is like "watching a foreign film without the subtitles".

She expressed despair when she described her images of learning mathematics. She felt that,

"because I don't, I could never, I never understood what they... You get told what to do but I never knew like why do I do this and how do I end up with this answer. Even if I ended with the right answer, why do I end up with this?" (text-unit 13).

During some parts of the interview, she blamed her mathematics teachers for her failures and negative attitude towards mathematics. For example, when she was asked if anybody else might have influenced her images of mathematics, she replied that

"everyone else in my family likes maths. May be I just had a bad teacher that puts me off and I decided that I didn't like it " (text-unit 17). In another occasion, she agreed that some people have inherited mathematical ability, "probably to some extent, But I think everyone will probably managed it if they were taught properly in school" (text-unit 43).

She also complained her mathematics teacher did not explain well and most often, she was just told to "do this do that, ...and no one told you why you do it" (text-unit 25).

However, she has started to change her view about mathematics because she will soon have to teach mathematics to her students. It is also partly because her present teaching course has introduced her to some practical activities and she found these activities very interesting and practical. Thus she intends to apply them and promises to make her mathematics teaching more exciting and interesting to her students.

To conclude, these cases illustrate that although these respondents may have different images of mathematics such as liking or disliking mathematics, perceiving mathematics as 'difficult' or as challenges. Their mathematics learning experiences in school, especially their mathematics teachers seem to play a significant role. Perhaps these findings are not surprising at all, but they point to the fact that a good mathematics teacher is like any other subject teacher, he/she needs to be able to explain well, have a lot of patient, inspiring and encouraging as well as have close rapport with his/her students.

IMPLICATIONS FOR MATHEMATICS TEACHER EDUCATION

Both review of literature and findings of the study indicate the important role of mathematics teachers in students and adults' images of mathematics and learning of mathematics. Firstly, teachers' beliefs about mathematics and images of mathematics may directly or indirectly influence their students' beliefs and images of mathematics. Moreover, these attitudes, beliefs, images of mathematics seem to persist till adulthood. In particular, teachers' attribution about students' success in mathematics were found partly contribute to either motivate or demoralise their students' (who become adults later) interest in mathematics. When these students or adults become parents later, will their negative view or images of mathematics be passed on to their children too?

Secondly, mathematics teachers, particularly in terms of the impact of their personalities and teaching styles were quoted by many respondents in the study as one of the most salient determining factors for their liking or disliking mathematics, and subsequently their choices of taking up higher level mathematics (or not).

I think, teacher has an enormous influence... I think it is very easy to be put off by mathematics, as you know, mathematics is too difficult. It is easy or seen as an obstacle for a student if that happen earlier on, the choice like between the humanities and science. If you are not seen as a mathematics student, then it is very easy to lose confidence in maths.

(R220, text-unit 21, speech and language therapist, female, 41-50, likes maths)

Likewise, to infer further, this may extend to influence their children's career choice and course choice in mathematics. There are some studies (Pedersen, Elmore, & Bleyer, 1986; Dick, & Rallis, 1991) which show that parents' attitudes towards certain subject may influence their children's choice of taking up that subject.

In short, teachers seem not just influence students' beliefs, images, attitudes towards mathematics, but this influence may persist to their course and career choice, as well as their children's future course and career choice too. This implies the important role of mathematics teacher in mathematics education. It also implies the great responsibility of the mathematics teacher education programme to produce good quality mathematics teachers.

As suggested by the respondents of the study, the characteristics of mathematics teacher of those who claimed to like mathematics stressed three aspects of teachers': (a) teaching approaches; (b) personalities and (c) rapport with students. This implies the need to incorporate these three aspects into the mathematics teacher education programme. In terms of teaching approach, they should explain the subject well and give their students enough practices on mathematics. In terms of personality, they should be inspiring and encouraging, and give enough attention and time to their students.

Perhaps this list of characteristics of a good mathematics teacher is not surprising in view that these are also the list of characteristic for a good teacher of any subject. However, as one of the respondents pointed out that unlike other subjects (such as History or English), mathematics being such a "boring" and "difficult" subject, teacher's well explanation is particularly important. Many students found that they can improve other subjects by self-study, but not mathematics.

To conclude, mathematics teachers' influence may result in a vicious cycle where teachers' personality and teaching approaches influence their students' attitudes and interest in mathematics, which further influence their choices of future course or careers. This in turn may influence their children's' images of mathematics when these students grown up and become parents, or alternatively, they may influence their students' images of mathematics if they become mathematics teachers later. In fact, this whole cycle may perpetuate and eventually influence the public's images of mathematics. Therefore, it is of up most importance that how can we ensure that mathematics teacher education programme produce or promote good and efficient mathematics teachers who are not only inspiring and encouraging, but also explain well and make mathematics lesson enjoyable for all their mathematics students.

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