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Novice and Senior Mathematics Teachers: Any Differences?

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Abstract

Novice and Senior Mathematics teachers' lessons were observed and video-taped. Their characteristic features of presentation of mathematics lessons were analysed and coded. Their behavioural features were classified with reference to two models: Mathematical Teaching Techniques (MTT) and Assessment of Practicuum Teaching (APT). Teachers' profiles of presentation were identified to differentiate any differences between these two groups of teachers. Research results show that Senior Mathematics teachers demonstrates more pedagogical features in teaching mathematics.

Introduction

Mathematics has been conceived as a difficult subject by many pupils in school. Its difficulty has caused much anxiety and fear to pupils who failed mathematics frequently. Some teachers who are unaware of the problems tend to pass the blame to pupils for their lack of aptitude, their negative attitude and inattentiveness in class. However, they do not realise that their style of teaching may also lead to pupils' failures in mathematics. Although a perfect method of teaching mathematics may not be available, a teacher may venture into some innovative methods of teaching to increase his/her probability of success. A project was conducted to determine the skills of novice and senior teachers in teaching mathematics. The results obtained from the project could provide further insights into teaching mathematics. These could also help to enhance teachers' techniques of teaching mathematics.

Initially, some innovative techniques of teaching mathematics were searched from literature. This has led to the development of a set of Mathematical Teaching Techniques (MTT) which forms a basic model for evaluating teachers'

mathematical competency in teaching mathematics. The model incorporates some learning theories advocated by Bruner (1968), Ausubel (1968), and Dienes (1971). Another model, the Assessment of Practicuum Teaching (APT) developed by the National Institute of Education (NIE), together with the MTT, were used as a basis for describing teachers' skills in teaching mathematics.

Theoretical Perspective

Mathematical Teaching Technique (MTT) Model

Teaching of mathematics is conceptualised to comprise three main stages, namely: (a) the introduction of a mathematics lesson, (b) the main body of the lesson, and (c) the conclusion of the lesson. When a mathematics lesson is introduced, preferably pupils should first be motivated to ensure that they find learning is meaningful. This could be done by spelling out the objectives and/or structure of the lesson before the main part of the lesson is introduced (Ausubel, 1968).

When the lesson is in progress, pupils' interest should also be sustained through meaningful teaching and using familiar experiences. Basically, meaningful teaching and provision of familiar experiences, classified here as motivating factors, should be seen as an important factor in teaching a mathematics lesson. Without these, pupils tend to find learning meaningless especially when they are introduced with enormous amount of unfamiliar and abstract mathematical knowledge.

The other areas involved at the second phase of teaching are teaching of concepts, teaching of skills and strategies for problem solving. Meaningful-learning concept is also applied at this stage. Appropriate psychological principles which would be useful for teaching mathematical concepts are sequencing of materials (Dienes, 1971), using contrast technique and using perceptual and mathematical varieties, constructing mathematical rules, using short cut for problem solving and summarising problem-solving procedures. All these techniques are not meant to be used in sequence but applied at the appropriate time.

Assessment of Practicuum Teaching (APT) Model

In supervision of mathematics teaching, besides mathematical skills, teachers are also expected to apply generic skills in teaching. The generic model for evaluating a lesson in teaching under discussion here is based on the NIE Model for evaluating teacher's performance in practicuum teaching. The model comprises 5 main constructs: planning, inducting, communicating, managing and evaluating.

The **planning** stage of a mathematics lesson involves recording of activities to be carried out during the lesson. Some activities included in the lesson plan are preparation of detailed contents of the topic to be taught, materials (such as manipulatives and worksheets) for different-ability pupils and audio-visual equipment to be used in the lesson. Notes for summary of lesson should also be documented in the detailed lesson plan.

The second stage of the model, **inducting,** includes the followings: using the concepts of advance organiser & meaningful learning, arousing interest and stimulating thinking. In a mathematics lesson, the advance-organiser concept refers to the provision of an overall structure of the lesson so that learners may be able to relate concepts between different mathematical topics. Learning becomes more meaningful if they are provided with concepts which are connected with what they have learned. In order to capture pupils' attention, they should be aroused at the beginning of the lesson and at the time when pupils do not concentrate. This could be done through stimulating their thinking by throwing out some provoking questions to pupils so that they are given the opportunity to reflect and recall relevant knowledge to accommodate the new ideas.

The third category of the model is **communication.** Communication is concerned with explaining, informing, questioning and responding, using voice, command of language and using media & resources. Explaining is a key feature of teaching process in which mathematical concepts can be conveyed to pupils if it is systematically planned and presented. For example, in teaching mathematics, explaining should be presented by sequencing materials from simple to complex. Using contrast to explain mathematical concept is another effective approach to help learners conceptualise the concept. The other key feature of communication is questioning which is used as a form of formative assessment to check the progress of pupils in the class. The use of media and recourses is useful when a teacher is dealing with pupils with lower ability. As most mathematical concepts are abstract,

the use of concrete materials and diagrams may be helpful to pupils to conceptualise the mathematical concepts.

Another feature of the APT Model is **managing**. Managing comprises four areas: establishing rapport, managing behaviours, managing group/individual work and managing time. Teachers are expected to build up a cordial relationship with pupils so that no fear arises among the pupils. They are able to concentrate in their lessons if such relationship can be built up between the teachers and pupils. Group and individual work are part of the learning procedures in the classroom. A teacher should plan a systematic lesson to organise activities such that all pupils are involved in the work. The other factor which affects group work or individual work is time management. Hence a teacher needs to take into consideration whether sufficient time is given to complete a certain task in group or individual activity.

Evaluating is an essential feature in practicuum teaching. Evaluation involves: feedback to be given to pupils, monitoring pupils' understanding, encouraging pupils to self-evaluate their solutions. Teachers are expected to provide feedback to pupils after they have been assessed on their work. Pupils' work could be in different forms: home work, class work, responses from teacher's questions and tests. Teachers should also use the pupils' work as a form of resources for conducting remedial lessons. An assessment could be carried out as a formative assessment or a summative assessment. For the former, teachers can monitor pupils' understanding of mathematics taught in the class. An immediate feedback to them is an effective method of teaching mathematics. Besides assessing pupils' work, pupils could also be encouraged to assess their own work. For example they may be asked to check if their solutions or answers are correct after they have completed solving the problem. In this context, they are also required to make an estimation of the result obtained in solving a problem.

Purpose of the Study

The purpose of the study was twofold. The primary objective of the study was to determine whether novice or senior mathematics teachers have acquired and able to apply some mathematical & generic skills in teaching mathematics. The secondary objective is to classify the characteristic features of the novice and senior mathematics teachers, if any.

Methods And Procedures

In order to determine the characteristic features of novice and senior mathematics teachers, a qualitative approach was adopted in this study. The procedures of this study were divided into 5 stages: (1) reviewing of effective methods related to teaching and learning of mathematics, (2) collection of qualitative data on novice and senior mathematics teachers' teaching behaviours by video-taping their lessons, (3) transcribing video-taped data into hard copies for analysis, (4) coding data, and (5) analysis of data to determine teachers' behavioural features. The first stage on reviewing effective methods of teaching mathematics has been documented in the previous sections. The following paragraphs describe the other stages of the study.

Collection of Qualitative Data

Subjects

The subjects of this study were 4 pre-service (novice) teachers and 2 in-service (senior mathematics) teachers. All the subjects were females. The 4 novice teachers had graduated with their first degree in mathematics and had completed their training in secondary mathematics curriculum studies. At the time of study, they were attached to schools for practicuum teaching. The 2 senior mathematics teachers selected had at least 15 years of teaching experience. They were also holding senior positions in their secondary schools.

Video-taping Teachers' Lessons

Before all the 4 novice teachers were posted to schools, they were briefed on their expectations according to the requirement of the APT evaluation form. They were also told that their first lessons would be video-taped so that discussion between the supervisor and the students could be carried out after the video-taped lessons have been analysed. During post conferencing, the novice teachers were advised on their strengths and weaknesses of their lessons.

The two senior mathematics teachers were negotiated to help in the project. Each of their mathematics lessons were also video-taped in the same manner. However, they were not briefed on their expectations but they would only be required to carry out their teaching in their usual manner.

Analysis of Data

Transcription of Video-taped Lessons

Three part-time research assistants were employed to help transcribing the video-taped lessons into hard copies. They were told to record the exact words spoken by the teachers & the pupils and dialogues between them. The actual mathematical sentences, statements and formulae written on the board were also recorded in the same way as they were written on the board.

Coding and Method of Analysing Data

At this stage of the project coding of teachers' behaviours was recorded. The codes for describing characteristics of teachers' behaviour were based on the MTT model and the APT model. However, there were some observed behaviours of teachers which could not be explained or classified using either of the two models. In such cases, new names were given to describe these new characteristics.

In the analysis of data, each and every line of the transcribed data was carefully read through to determine if the behaviour of the teachers (represented by the transcribed sentences) could match any of the characteristic features of the models. When they were identified, they were coded immediately by writing the feature next to the statements read. Sometimes sub-features were coded and classified.

A summary of each teacher's behaviour was made to show her teaching profiles in the mathematics lessons. The data were re-examined to determine their strengths and weaknesses in teaching mathematics.

Research Results

One objective of the study is to determine the different types of skills used by novice and senior teachers in mathematics lessons. Another objective is to determine if there were any differences between the novice and senior teachers in their styles of teaching. In order to achieve these objectives, the first step is to identify all the subjects' behavioural constructs in their teaching. Secondly, each teacher's teaching profiles would be identified based on the data obtained from the

previous paragraphs. The following sections show the classification of teachers' behavioural features and summary of the novice and senior teachers' profiles.

Classification of Behavioural Constructs/Features

The analysed results show that each teacher has a distinct behaviour in her style of teaching mathematics. Their behaviours can be described with reference to a set of teaching constructs which could be explained on the basis of the MTT and APT models. However some features identified could not be classified under any of the two given models. In general, three categorical behavioural constructs which could be classified in this study are (1) Generic Pedagogy, (2) Mathematical Pedagogy and (3) Affective Construct.

Generic Pedagogy

Under this category, four teaching behavioural constructs were identified from the analysis. They are advance organiser, explanation, questioning and evaluation. The following paragraphs describe these constructs identified from the observed lessons of novice and senior teachers.

Advance Organiser

The main features identified under this categorial construct are stating objectives of lessons and linking present topic with the topics taught in the previous lessons. The followings are evidences obtained from the video-taped lessons. (Note: NT stands for novice teacher and ST stands for senior teacher)

NT 1: This is important when we talk about prime numbers. That's what we are going to do today. (objectives of lessons)

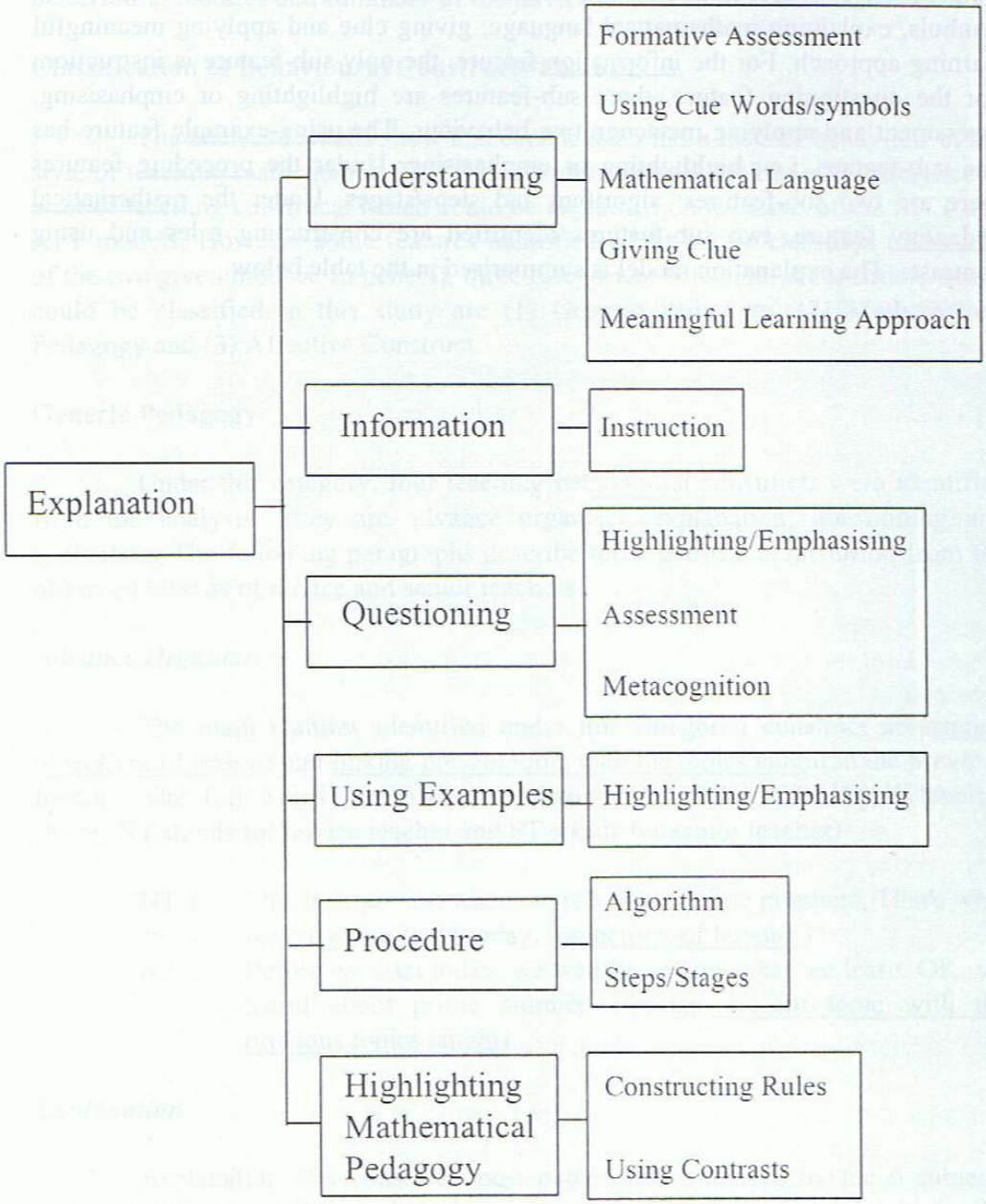
NT 2: Before we start today, we want to review what we learn. OK, we learnt about prime number. (linking present topic with the previous topics taught)

Explanation

Explanation is a construct most extensively practised by the 6 subjects under-studied. Under this explanation construct, seven categorical features can be further classified. They are (1) understanding, (2) information, (3) questioning, (4) using examples, (5) procedure, and (6) mathematical pedagogy. These six features

can be further classified into sub-features. For the understanding feature, five sub-features were observed. They are formative assessment, using cue words or symbols, explaining mathematical language, giving clue and applying meaningful learning approach. For the information feature, the only sub-feature is instruction. For the questioning feature, three sub-features are highlighting or emphasising, assessment and applying metacognitive behaviour. The using-example feature has one sub-feature, i.e., highlighting or emphasising. Under the procedure features there are two sub-features: algorithm and steps/stages. Under the mathematical pedagogy feature, two sub-features identified are constructing rules and using contrasts. The explanation model is summarised in the table below.

Table 1. Sub-Categories of Behavioural Constructs Under Explanation



For each of the sub-features, evidences can be obtained from the video-taped lessons. The following paragraphs show these evidences.

Understanding - Formative Assessment

NT 1: Let me ask you a question. Is 1 a prime number? OK. How many of you say yes? How many of you say no? Four of you say no.

Understanding - Using Cue Words/Symbols

NT 1: OK. I wrote there. So fill in the blanks. A prime number ....a prime number has different factors and I boxed the different up. What does that mean? It must have two different factors.

Understanding - Explaining Mathematical Language

NT 1: Did you all get that. So for any natural number starting from 1, except 1, because 1 is not a prime number and is not a composite number, that's why I say "except", excluded.

Understanding - Giving Clue

NT 4: Class? Because you have the same base. Which laws do you use? $a^m x b^m$, right? Even though it is negative you still use the law.

Understanding - Applying Meaningful Learning Approach

NT 4: T: OK, now we go on to indices involving indices. What do you know, understand about equation?
S: Balance
T: There is be balance, left and right must be the same.
S: The same.
T: What is the same?
S: Equation equal.

Information - Instruction

NT 1: OK. Now, so if all have understood what is a prime number, let's see whether you all can do this problem. OK, in your notebook, you just turn over the page before you paste the second handout that I gave you. OK?

Questioning - Highlighting/Emphasising

NT 1: OK. Can you all turn to your maths notes-no.5. Now, what is a composite number? A composite number has more than 2 different factors. OK. What do I mean by that?

Questioning - Assessment

NT 3: Given that the volume of sphere is directly proportional to the cube of the radius. ..... Now what do you mean by directly proportional.? Who can tell me?

Questioning - Applying Metacognitive Behaviour

NT 2: OK, so we have eleven. Once again is there any multiples of eleven from the remaining numbers? No, similarly the next uncross number is 13. Yes, we miss out this and what else? Seventeen?

Using Examples - Highlighting/Emphasising

NT 1: Just look at the number 4. 4 is equal to 1x4 which is equal to 2x2 also, OK? Now 4 is clearly not a prime number but it is a composite number.

Procedure - Algorithm

NT 2: .... to look at the two, we circle two, OK. And we want now cancel those numbers in this list that is a factor.....

Procedure - Steps/Stages

NT 2: Easy. Now the second thing you would do is to cross out, OK. Look at this number, the next uncrossed number..... The next thing to do is to cross out numbers which has three as factors.

Mathematical Pedagogy - Constructing Rules

ST 1: Alright, now what is the minimum point? Now you see this the positive coefficient of x^2 so you expect to see the curve and min point.

Mathematical Pedagogy - Using Contrasts

ST 2: You bring out the common factor, alright and factorise for (a+b) so this applies to addition and subtraction. For multiplication you multiply, correct?

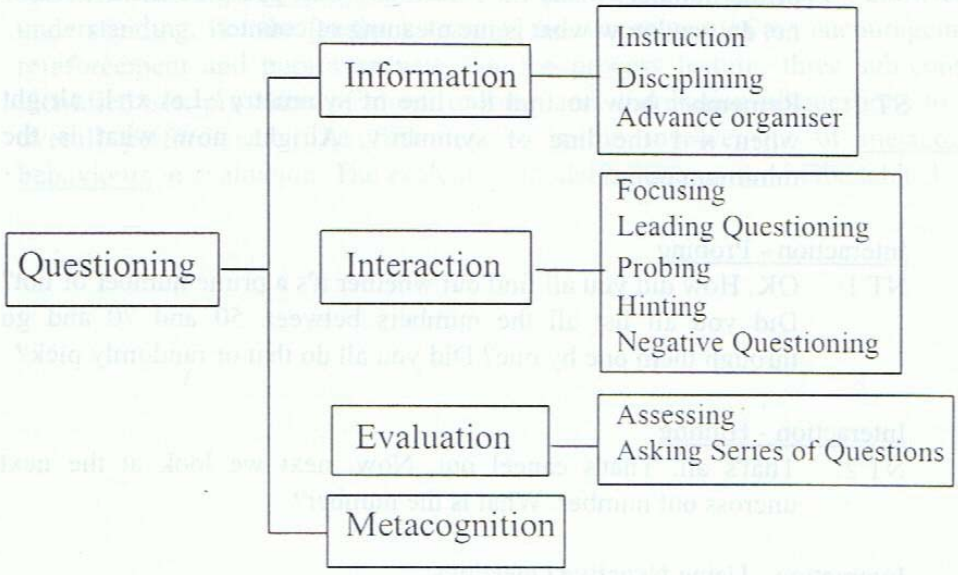
Mathematical Pedagogy - Simple to Complex

NT 4 : So equation involving indices usually the equation is $2^x=4$, this is only very simple equation but it involves indices. It may look something like this $3^x=81$. This is an equation and the z here is in the index form.

Questioning

Questioning is also another construct extensively used by the 6 subjects. Under this questioning construct, four major features were identified: (1) Information, (2) Interaction, (3) Evaluation and (4) Metacognition. Each construct can be further classified into categorical features. For the informative feature, three sub-features are observed. They are instruction, disciplining and advance organiser. For the interaction feature, five sub-features identified are focusing, leading questioning, probing, hinting, using negative questioning. The evaluation feature can be further classified into two categories: assessing and asking series of questions. The metacognitive feature does not have sub-categories. This questioning model is summarised in the following table.

Table 2. Sub-Categories of Behavioural Constructs Under Questioning



For each sub-features, evidences could be obtained from the video-taped lessons. The following paragraphs show these evidences.

Information - Instruction

NT 1: Did you bring it to-day?

Information - Disciplining

NT 3: Why are you all talking?

NT 3: Show me your work, didn't do? Kawei, what?

Information - Advance Organiser

NT 1: We are going to talk about prime numbers and composite numbers. OK, what is a prime number? Can you look into this before I go into that .....

Interaction - Focusing

NT 2: Now, we look at question four. It says what is the largest prime number less than hundred? OK refer to your list. What is the largest prime number? Yes?

Interaction - Using Leading Questions

NT 2: OK, from the list, you have come out with, is every odd number a prime number? What do you think? Can you give me a counter i.e. do you know what is the meaning of counter.

ST 1: Remember how to find the line of symmetry? Let x=1, alright when x=1 the line of symmetry. Alright, now what is the minimum point?

Interaction - Probing

NT 1: OK. How did you all find out whether it's a prime number or not? Did you all list all the numbers between 50 and 70 and go through them one by one? Did you all do that or randomly pick?

Interaction - Hinting

NT 2: That's all. That's cancel out. Now, next we look at the next uncross out number. What is the number?

Interaction - Using Negative Questions

NT 2: Narawathi, why do you think Rubin is not correct?

NT 2: Why do I exclude number four?

Evaluation - Assessing

NT 2: Is four a prime number? What do you think?

Evaluation - Asking Series of Questions

NT 3: Anybody can do this? Yes Kok Heng? How do you do this? Tell me what you did? What laws do you use?

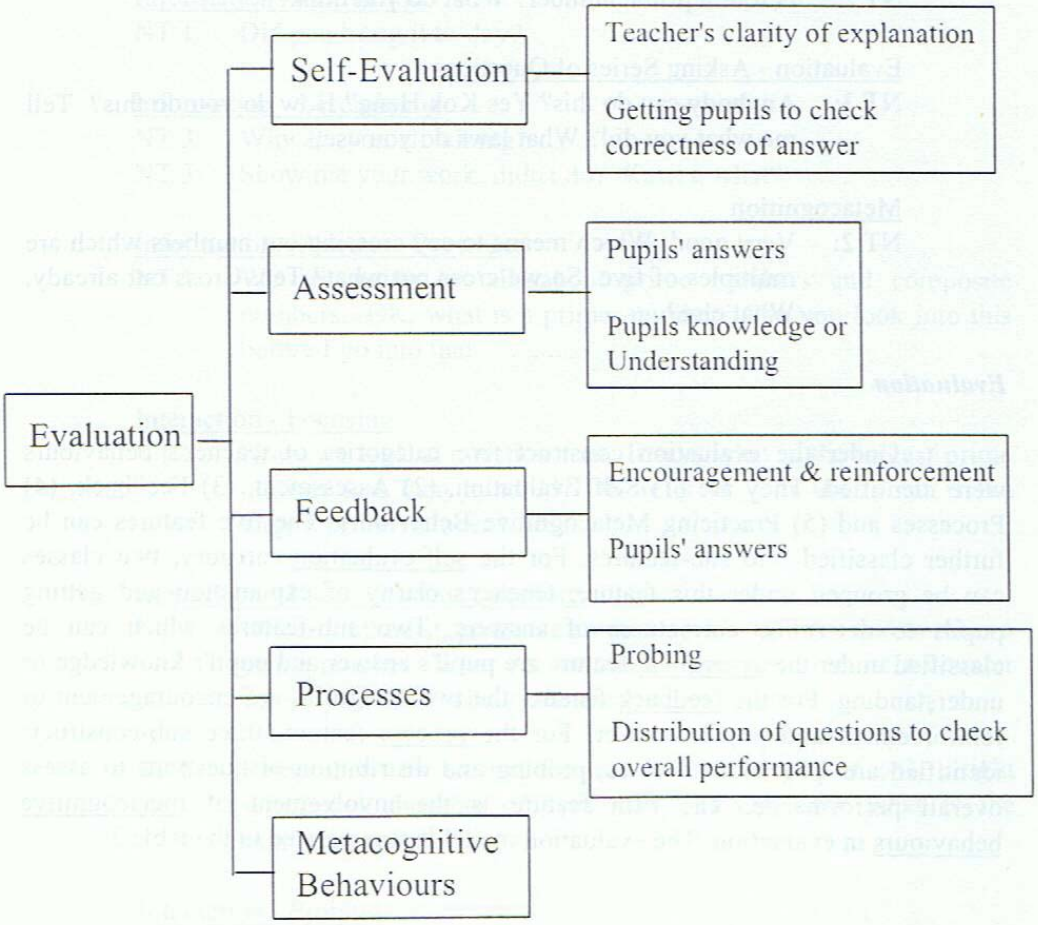
Metacognition

NT 2: Very good. Which means to say crossing out numbers which are multiples of five. So we cross out what? Ten. Cross out already. What else?

Evaluation

Under the evaluation construct five categories of teacher's behaviours were identified. They are (1) Self Evaluation, (2) Assessment, (3) Feedback, (4) Processes and (5) Practicing Metacognitive Behaviours. The five features can be further classified into sub-features. For the self-evaluation category, two classes can be grouped under this feature: teacher's clarity of explanation and getting pupils to determine correctness of answers. Two sub-features which can be classified under the assessment feature are pupil's answer and pupil's knowledge or understanding. For the feedback feature, the two categories are encouragement or reinforcement and pupil's answer. For the process feature, three sub-constructs identified are: provision of clues, probing and distribution of questions to assess overall performance. The fifth feature is the involvement of metacognitive behaviours in evaluation. The evaluation model is summarised in the table 3.

Table 3. Sub-Categories of Behavioural Constructs Under Evaluation



For each of the sub-features, evidences can be obtained from the video-taped lessons. The following paragraphs show these evidences.

Self Evaluation-Teacher's clarity of explanation

NT 1: OK, and this is the same for 11 and 32 and 31 and it will be the same for any other number. Am I right?

Self Evaluation-Getting pupils to check correctness of answer

NT 1: One way that I can suggest is that you can list down the numbers. Let's say between 50 and 70 is 51, 52, 53, 54 and so on until 69. Now, then you ask yourself - are all like 52, 54 they are all called even numbers.

Assessment - Pupils' answers

NT 2: Oh, you got twenty-seven, OK. Who got twenty five? OK, the majority of class got twenty five. OK, this is correct, OK. I want you to go back and check your working .....

Assessment - Pupils knowledge or understanding

NT 3: T: Now what do you mean by directly proportional.? Who can tell me? Heo Koon?
S: Directly proportional
T: Yes, varies directly.

Feedback - Encouragement & reinforcement

NT 1: Pupil : 11 and 31
Teacher: Good, 11 and 31.

Feedback - Pupils' answers

NT 2: student: 9
teacher: what else?
student: 12
teacher: 12 is out

Processes - Probing

NT 1: The rest. Show your hand, who didn't do. What happened? ..... Esther can put down.

Processes - Distribution of questions to check overall performance

NT 2: Twenty-five, OK. Nelson, do you agree with that? What do you have? Twenty-three. Nelson has twenty-three. OK, we have got twenty-five.Any more answers? Yes.

Practicing Metacognitive Behaviours.

ST1: Which part of the graph ranges from 0 to 9. Can we just look at this part. Is the graph ranging from 0 to 9 from this?

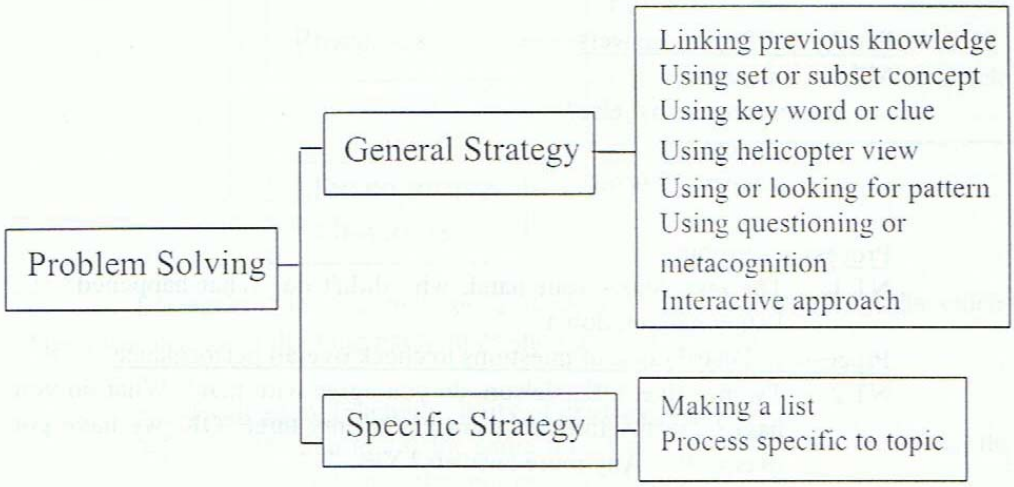
Mathematical Pedagogy

Teaching of mathematics requires the use of both generic and mathematical pedagogies. The following paragraphs summarise the mathematical pedagogical skills which were identified from the six subjects. The constructs identified are problem solving, mathematical thinking, variability of materials, construction of mathematical rules and summarising problem-solving strategy.

Problem Solving

In solving mathematical problems, a number of strategies used by the teachers were observed. They could be classified as general or specific strategies. For the general strategies, seven of them observed are (1) linking-previous-knowledge strategy, (2) using set or subset concept, (3) using key word or clue, (4) using or looking for pattern, (5) using questions or metacognitive behaviours, (6) interactive approach and (7) using helicopter view. For the specific strategies two of them identified are making a list and process strategy. They are specific strategies related to the topic. The set of strategies is summarised as follows.

Table 4. Sub-Categories of Behavioural Constructs Under Problem Solving



For each of the sub-features above, evidences can be obtained from the video-taped lessons. The following paragraphs show these evidences.

General Strategy - Linking previous knowledge

NT 2: Remember what we stop last week..... if we want to list down, ok, the prime number that is less than ten. It's very easy. Now let's say we want to list the whole list of prime numbers. .....What do you do?

General Strategy - Using set or subset concept

NT 1: Now, class, you don't have to think so hard because you have already taken out the prime numbers. So remember every natural number is either a prime number or a composite number. right?

General Strategy - Using key word or clue

NT 1: OK. The problem says: Find 2 prime numbers whose sum is an odd number". So what is the key thing? 2 numbers.Now, you must have 2 numbers. These numbers must be prime numbers, OK?

General Strategy - Using or looking for pattern

NT 2: The question ask, find whether a number is prime number or composite number. So what is the first thing that you do? OK, you want to find out, OK. the number of factor, OK that this number has right and based on the definition of prime number and composite number, OK. If this number you can find for this number more, two, two factor only, whereby one factor is one and the other one is itself. Can somebody tell me what number can conclude from here?

General Strategy - Using questioning or metacognition

ST 1: Alright, so we begin with quadratic curve. We look at x^2. The coefficient of x^2 is positive so you expect to get a ...? Alright, now what is the minimum point? Now you see this the positive coefficient of x^2 so you expect to see the curve and min point. So what is the min value of the point?

General Strategy - Interactive approach

ST 2: Q: 8 less then the quotient of 16m divided by 12n.
T: What is the meaning of quotient?
S: Divide
T: Yes, the answer you get after you have divided. 8 less than the quotient of 16m/12n. How many ideas are there, operations?
S: 2, subtraction and division
T: How do you know that, there is subtraction involved?
S: Less
T: Less than, division involved?
S: Quotient
T: Alright, how are you going to put it down? What are you looking you divide first or subtract first?
S: Divide

General Strategy - Using helicopter view

ST 1 : Now first of all you have to sketch the graph, right. What type of curve will it be? What kind of curve you call it?

Specific Strategy - Making a list

NT 1: OK. 59-list or not? 61-list or not? I'm sure you all got that and then ask yourself whether it is a prime number or not. One way that I can suggest is that you can list down the numbers. Let's say between 50 and 70 is 51, 52, 53, 54 and so on until 69.

Specific Strategy - Process :specific to topic

NT 4: Now, let's try it. What you need is either change to the same base. This one also, you find the common factor. Here is 2. ..... In this case what should I do first? I change all to the same base. For this case $16=2^4$. if you not sure $16=4^4=2^2$, 16 you follow or we change this first.....

Mathematical Thinking

Mathematical thinking is seldom practised by the teachers under observation in this study. However, in two occasions, mathematical thinking was observed in one of the teachers' lessons. Two features which observed under this construct are use of implication and logical reasoning.

Evidence which shows the use of implication in argument is shown in NT 1 observed lesson.

> NT 1: Do you all notice that what you have, like 22, say. OK. We will always have 1x22. OK, and this is the same for 11 and 32 and 31 and it will be the same for any other number. Am I right?

Logical reasoning is observed in the same subject as follows:

> NT 1: But are odd numbers prime numbers? Some of them. That means not all odd numbers are prime numbers - only some. OK? Now, just now we have seen some, right? Like 55. 55 is an odd number but it is not a prime number. So may be you can add something here. Are 'all' odd numbers prime numbers. The answer is no.

Variability of Materials

This mathematical construct was observed in both the expert teachers (ST 1 and ST 2). Variety of questions were selected in their presentations. The followings are examples used by ST 2 in the observed lesson.

Questions:

1. Add 5 to h
2. Add 5h to 15g
3. Add 5h to 10h
4. Subtract b from 24a-b
5. Multiply 3u by 7s

Construction of Mathematical Rule

Construction of mathematical rule is also another form of mathematical pedagogy practised by one of the expert teachers. This technique helps pupils to conceptualise and remember some of the rules used for problem solving. For example, ST 1 uses an analogy of smiling face for a parabolic curve with a minimum point. Similarly a sad face is used to indicate a parabolic curve with a maximum point.

Summary of Problem-Solving Procedures

Summarising the procedures for solving mathematical problems at the end of the lesson provides reinforcement of knowledge acquired during the lesson.

Summarising could be generic or mathematical. The followings are the two features identified.

Generic Summary

NT 2: OK, therefore, we summarise what we have to day. We have talked about this method to list the prime numbers .....

Mathematical Summary

NT 1: So 53 is a prime number, 59 is a prime number. ..... Good, what about 65? Because it can be divided by 5. Very good. What about 67? Yes, now what about 69? No because it can be divided by 3. OK? So there's only 53, 59 and 67.

Affective Construct

Besides the generic and mathematical pedagogies, affective behaviours were observed in the subjects understudied. The paragraphs below show their affective behaviours and evidences gathered from the video-taped lessons.

Consoling

NT 4: S: The question is wrong.
T: Right, never mind, if let say leave it like this. Now I want to go to the next section - Equation involving indices. Don't worry you get to do your assignment afterwards. You got two days on Thursday is your next lesson.

Showing Encouragement

NT 1: S: It can be divided by 3.
T: Good. What about 59?

Using Harsh Statement

NT 3: Why you take so long? Check your text book? Don't have?

Making Caution Statement

ST 2: .....since this is the first time you are doing algebraic expression I will like to remind you that there should be pair of brackets. Can you simplify the answer?

Teachers' Profiles

Based on the behavioural constructs identified from the previous sections, both the novice and senior mathematics teachers will be described in terms of these identified constructs.

Novice Teachers

Generic Pedagogy

From the analysed result, novice teachers were found to apply generic pedagogies quite frequently with respect to **advance organiser**, **explanation**, **questioning, evaluation and summary**. In their lessons, objectives of lessons were stated and efforts were made to link previous topic with the current topic understudied.

Emphasis was made in understanding when concepts and mathematical language were explained. In the process of explanation, cue words were used to highlight some important points. Highlighting using specific examples was also used to explain concept. One teacher provided information to further strengthen children's understanding of mathematical concepts. Formal assessment was also applied in explanation. Another feature observed was interactive dialogue between teacher and pupils in her explanation.

Various types of **questioning** were applied by novice teachers. Questions were used to focus on some important concepts in order to capture pupils' attention. Leading questions were used to help explanation. Teachers were observed to probe on pupils' strategies. Metacognitive behaviours using questioning were also observed in one novice teacher. Disciplining using questions was another feature identified. Other functions of questioning include hinting and using negative questioning.

In many occasions, one novice teacher self-**evaluated** if her explanation statements were clear. Assessing on pupils' work or knowledge was also used in the lessons. Feedback was also provided to pupils after assessing their work. Pupils were also asked to self-evaluate on the answers obtained by them. Probing was seen to use for evaluating pupils' methods of solving problem. Distributing the same question to different-ability pupils was applied by one novice teacher for assessing pupils' understanding of concepts.

Summarising of what had been done in the lesson was observed in two novice teachers.

Mathematical Pedagogy

Under this pedagogical category, the major construct observed is problem-solving. The other construct which can be observed from the novice teachers is summarising problem-solving procedure.

Two identified constructs under problem solving were relating previous knowledge and using pattern for solving problems. Another problem solving process identified was based on didactic process. Another approach in problem-solving process was by interpreting question statements.

Besides problem-solving process another mathematical construct applied by one novice teacher was simple-to-complex principle in her presentation. Summarising problem-solving procedures was observed in one of the novice teachers' lessons. This pedagogy provides an overall structure of problem- solving strategy which helps pupils to retain knowledge learned by them.

Affective Behaviour

One construct identified in a novice teacher's lesson was consoling pupils. Assurance was given to pupils that everything would be fine. Another teacher had shown warmth to the pupils. In many occasions, she had shown encouragement to them too. In comparison, another teacher behaved just in the opposite way. She had shown harshness to pupils and had threatened to punish them. Very little encouragement was shown in her lesson.

Senior Teachers

Generic Pedagogy

The senior teachers applied similar generic pedagogies such as explanation, questioning and evaluation. To a lesser extent, one of them made use of evaluation, advance organiser and summarising problem-solving strategy in her lesson. However, the second teacher did not use advance organiser in her lesson.

In **explanation**, the following features were observed in the senior teachers' lessons: getting pupils to focus on the points made by repeating questions, highlighting main points, emphasising on the use of constructing mathematical rule, using contrast and emphasising the use of mathematical language. Metacognition was also applied by one of the teachers.

Questioning was frequently used in both teachers' lessons. Three important features were applied in the lessons: using leading questions, getting pupils to focus on the main parts of the question and applying metacognition in questioning. The following are extracted from their lessons to show these features:

In **evaluation**, one of the teachers used series of questions for assessing pupils' understanding of concepts learned. In the process of questioning, metacognitive behaviours were applied.

Mathematical Pedagogy

Thorough **problem-solving** processes were observed in both teachers' lessons. In problem solving, a few generic strategies were observed in their lessons. The strategies used are: Helicopter View:, Metacognition, Interactive approach: and Using key word.

Besides problem solving processes, other mathematical pedagogical skills observed were use of construction of mathematical rule, use of contrast and variabilities of materials.

Affective Behaviour

Relatively, the senior teacher tend to be stricter than the novice teachers to their pupils. They have also shown to ensure that their pupils and to be more careful in their work.

Summary

The main purpose of the project is to identify what types of generic and mathematical skills were used by teachers in teaching mathematics. The procedures involved (1) examining the two models, MMT and APT and (2) comparing the two model feature with performances of the subjects understudied. The two models were used as the basis for the study. Two groups of teachers were selected: the novice teachers and senior teachers. Among the novice teachers, a mixture of strong and weak pupils were selected. Overall two subjects were selected from the senior teachers and four teachers were selected from the novice teachers. The novice teachers were first briefed on their requirements and methods of teaching. Then the novice and senior teachers' lessons were video-taped and transcribed into hard copies for analysis. Based on the transcribed data, 3 categorical constructs were identified: generic, mathematical and behavioural. Under each category, a set of sub-features were identified. Some of these identified features conform to the two models.

Strengths and Weaknesses of Novice Teachers

The results of the study show that novice teachers did make use of some features of the **generic construct** model in their teaching. In their teaching they emphasise a lot on three areas: explanation, questioning and evaluating. To a less extent they apply summarising at the end of lessons. A variety of behavioural features was observed. For explanation the following were observed: understanding, using cue words, highlighting with questions or examples, using specific examples, systematic procedure, using questioning, using meaningful learning and interaction approach. For questioning, some features used were using leading questions, probing, hinting, focusing and using metacognitive behaviours. Apparently this group of novice teachers was quite strong in explanation and questioning in terms of varieties. For evaluation, a vast variety of skills were also applied. They are self-evaluating, assessment on pupils' work, giving feedback and distribution of questions to assess overall performances of pupils. Summarising is

also practised in their teaching. Overall the novice teachers were satisfactory in their generic pedagogy.

A variety of **mathematical pedagogies** was used by the novice teachers. However, most of them were not derived from the MTT model. The following pedagogies were used by them: linking previous concept, set and subset concept, using cue words, using specific algorithm, using pattern for problem solving and using simple to complex principle. Apparently in terms of this mathematical pedagogy, the novice teachers were relatively weak in applying them.

For the **summarising** construct, only the better novice teachers were able to apply their concept.

Generally, the novice teachers showed encouragement, interest and warmth to their pupils.

Strengths and Weaknesses of Senior Teachers

The results of the study show that the senior teachers also made use of some constructs derived from the **generic** model in their teaching. They are: explanation, questioning and evaluating. However, they did not apply the summarising concept at the end of lessons. A variety of behavioural features was used in each of the constructs identified above. They are focusing by repeating questions, highlighting, using construction of mathematical rule and contrast, and explaining mathematical language. For questioning, some features used were using leading questions, focusing, using metacognitive behaviours and using key words. Apparently expert teachers were quite strong in explanation and questioning using various generic features. For evaluation, the features used were assessing which involved application of metacognitive behaviours. Summarising was not practised in their teaching. Overall the senior teachers were satisfactory in their generic pedagogy.

More sophisticated **mathematical pedagogies** were used by the senior teachers. Many of them conform to the MTT model. The followings are the pedagogies used by them: constructing mathematical rules, use of contrast, using helicopter view, applying metacognitive behaviours, use of key words, use of variabilities of materials and using simple to complex principle. Apparently in terms of mathematical pedagogy, the senior teachers were very strong in applying them.

For **summarising** construct, none of the two senior teachers apply the concept in teaching problem solving.

Generally, the senior teachers were very strict to their pupils. They were usually very careful and always made caution statement to them.

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