A Pilot Study of Mathematical Investigation for the High Achievers in Mathematics

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Abstract: In view of the school's vision to develop the pupils as 'Creative Thinkers' and the fact that pupils who are high achievers generally enjoy solving mathematical problems, it is deemed relevant to conduct a study in Mathematical Investigation pedagogical approach to the teaching of Mathematics. The study hopes to identify the key enabling factors in Mathematical Investigation pedagogy in assisting to develop pupils' ability in problem-solving. A homogenous group of 26 pupils from Primary 6 in Chongzheng Primary School participated in the pilot action research study. Two teacher researchers, trained in the Mathematical Investigation pedagogy, were appointed by the school principal to commence the study at the beginning of March 2006. Purposive sampling of pupils who met the 3 inclusion criteria were selected for the study: (a) Top 26 of the 84 pupils who sat for the selection test for the Math Olympiad Competition (b) Display traits of diligence and enthusiasm (c) Have above average Mathematics achievement in school assessments. Data sources include field notes from the site observation of two schools that offer the Gifted Education Programme, focus group interviews, direct observations, video-taping and reflection journals. Findings of the pilot study revealed that pupils understood the importance of teamwork and identification of patterns in problem-solving. The findings from the study are significant as they can be translated into problem-solving techniques that pupils will be equipped with in the later part of their lives. If pupils are given frequent practice in Mathematical Investigation, the problem-solving ability becomes second nature to them. Thus, it could enhance an individual's capacity in management, leadership and other professional disciplines. In conclusion, the preliminary theoretical construct can be regarded as an educational and developmental tool for personal growth and development.
Keywords: gifted, differentiated learning, Mathematical Investigation, pedagogy, traits

Background

We, the teacher researchers, are the Mathematics teachers of two higher-ability Primary 6 classes in a neighbourhood school in Singapore. Our pupils are 12 years of age on the average. The pupils are streamed into these two higher-ability classes by virtue of their school assessment results. However, among these pupils, there are some who are exceptionally talented in Mathematics. Despite having a faster pace of teaching and the inclusion of higher-order thinking questions during lessons and in their individual assignments, we still have to agree with Shoplik (1996) that they are usually the first to finish the class work and would sit at their desks looking bored or we would have to find other things for them to do. We feel that these pupils are generally very enthusiastic learners and display great perseverance in solving mathematical problems. We also observed that they like to be challenged, especially with tasks apart from the mundane worksheets.

Since pupils come to us with differences in many aspects like learning readiness, cultural background, interests, gender, talents, and learning profile, like Tomlinson (2001), we believe in the importance of being more proactive in differentiating our classroom instructions.

Hence, we conducted a pre-intervention interview with the focus group of 26 Primary 6 pupils from both our classes to hear their views about the Math lessons that were being conducted in class. The interview revealed that these pupils generally find the Math lessons in class too slow and boring. The reasons being that these pupils have either read up the topic on their own or their home tutors have taught ahead of us. Pupils in the focus group also indicated solving challenging word problems, engaging in peer discussions and Mathematical Investigation as their preferred modes of learning.

In view of the school's vision to develop the pupils as 'Creative Thinkers' and the feedback gathered from teachers, who are teaching or have taught higher-ability classes, and pupils in the focus group, it is deemed relevant to conduct a study in Mathematical Investigation pedagogical approach to the teaching and learning of Mathematics.

Objective

Since pupils enjoy doing challenging Math tasks and have indicated Mathematical Investigation as one of their preferred modes of learning, we wanted to conduct a study to identify the key enabling factors in Mathematical Investigation pedagogy in assisting to develop pupils' ability in problem-solving, for such an ability can be translated into problem-solving techniques which pupils will be equipped with for later parts of their lives.

Literature Review

To begin, we looked at the definition of 'Mathematical Investigation' as prescribed by Singapore Ministry of Education:

Mathematical investigation is an activity that is divergent in nature. It provides students with an opportunity to work on an open mathematical situation… In an investigative work, students use a variety of problem solving heuristics and thinking skills to solve investigative problems with emphasis on discovery of patterns and relationships.

(Singapore Ministry of Education, Assessment Guide to Primary Mathematics, 2004)

Unlike 'direct instruction' that effectively conveys a large amount of highly structured mathematics concepts (Grant 1989) to pupils, the investigative approach assumes that pupils have already acquire the basic skills and concepts. The investigative approach also taps on pupils' positive attitude and focuses on engaging them in the process of mathematical inquiry. Teachers merely take the role of facilitators in the latter approach.

The investigative tasks for the focus group are designed with several underpinning educational theories which look into maximizing pupils' cognitive development. Firstly, questions and situations presented to pupils for problem-solving are open-ended, as it is believed that pupils will then be put in the position of inquiry, and of finding out what the possibilities are. (Mooney, 2000) Secondly, in view of Vygotsky's idea that a child's cognitive development could be maximised through meaningful interactions with teachers and peers (Mooney, 2000), pupils were allowed to work in groups for all the tasks assigned in the course of the study.

Methodology

A homogenous group of 26 pupils from Primary 6 in Chongzheng Primary School participated in the pilot action research study. Purposive sampling of pupils who met the 3 inclusion criteria were selected for the study: (a) Top 26 of the 84 pupils who sat for the selection test for the Math Olympiad Competition (b) Display traits of diligence and enthusiasm (c) Have above average Mathematics achievement in school assessments.

To further confirm that the observable traits of the focus group coincide with those displayed by pupils in the Gifted Education Programme (GEP), we, the researchers, went on a one-day attachment each in two GEP schools. Through observing a total of five different classes in both schools, we witnessed how engaged the students were in their investigative work and the high-quality class interaction, that we envisioned for our classes in a normal neighbourhood school, the GEP pupils and their teachers were having. The GEP pupils also displayed traits of enthusiasm and high level of inquisitiveness which were similarly displayed by our pupils.

In one of the Math lessons, pupils got into their groups to investigate the maximum number of net figures a cube has. A net of a solid is a 2-dimensional figure that can be folded to form the solid. (Fong, 2004) The pupils started to use blank paper and pencil to sketch out the net figures of a cube. As we walked around, we discovered that the pupils were very much on-task and motivated. Two groups of pupils even spotted a pattern in deriving the maximum number of net figures by having the net figures divided into three levels; top level, middle level and bottom level. *(refer to Appendix 1.1)* Having provided the opportunity for pupils to discuss and explore for any possibilities, the teacher then confirmed that there is indeed a pattern in deriving the maximum number of net figures of a cube instead of merely using 'guess-and-check'. With reference to the definition of 'Mathematical Investigation' mentioned earlier, this activity is certainly not only of investigative nature but also emphasises on the discovery of patterns and relationships.

On seeing that activities of such investigative nature worked so well for the GEP pupils who displayed similar traits as the focus group, we were really eager to carry out 'Mathematical Investigation' with our pupils. We decided to design our first activity, consisting of two parts, of investigative nature with emphasis on patterns and relationships. Considering that *the goal for educating mathematically talented students in the regular classroom is to properly pace and enrich their study of Mathematics* (Shoplik, 1996), we also decided to try differentiating our pupils' tasks by carrying out the activity with the focus group during a one-hour Math lesson in class, while the rest of the pupils were doing corrections for some Math worksheets. The pupils involved in Mathematical Investigation moved to the back of the class to carry out the activity with the teacher researchers who functioned as facilitators.

While the pupils were engaged in the investigative task, we visited the different groups to make direct observations and video-tape their discussions. We observed that pupils got into their groups of either three or fours on their own. They enthusiastically discussed the problem and posed questions to us.

<u>Activity 1</u>

The activity was based on authentic situations where pupils had to calculate the simple and compound interests accrued on a principal amount of money and draw a conclusion if simple or compound interest yields a higher return. *(refer to Appendix 1.2)* They were to use the 'listing' method to work out the simple and compound interests respectively for the first few years in each of the situations. *(refer to Appendix 1.3)* The scaffolding that was provided for them thereafter served to help them derive the formulae to calculate the accumulated interests, A, by spotting relationships between the principal amount, p, time, t, and interest rate, r.

After each activity, we collected their feedback. Below is the list of common responses that we have consolidated.

<u>Pupils' Reflection (1): After the first activity:</u>
Question: Do you think that a formula is important? Why/ Why not?

- Yes, as when we got the correct formula, we find that it is easier to solve the problem.
- Yes, because it helps you to get an answer with a higher possibility of getting it right. If you can use a formula correctly, the question should seem easier to you too.
- Yes, the formula helps to solve questions when numbers are very big.
- Yes. Without formulae, there is no sum. Without sums, there is no Math. Without Math, there is no universe.

Question: How did you feel after you have derived the formula?

- I felt jubilant and satisfied with myself after spending effort to solve the question.
- I feel a sense of achievement and want to try out my formula.
- I felt elated as formulae are very interesting and it fascinates me.
- I felt satisfied as I felt that at last I had learnt something difficult.

Question: What did you do to overcome the difficulties in completing this task?

- By discussing this with our group calmly.
- I discussed with my friend and checked the formula. If we have different formula, we will not fight over that our answers are correct.
- I try to think deeper and try to understand the question.
- I asked questions so people can help me understand better.
- Calm myself down and think it clearly to find a way to solve a question. I also check my answers with my team mates to see if they have other answers.

Question: State 3 things you have learnt.

- Having teamwork would mean solving things extremely fast.
- How interesting a formula works.
- I have learnt shorter ways to solve questions.
- How interesting Math is.
- The amazing work you can get if you derive a formula."
- I had learnt how to spot a pattern.
- I learnt that comprehending a question is crucial to solve the problem.
- I learnt to be more careful and have a bit more patience.
- The "mysteriousness of formula"

<u>Analysis of pupils' feedback for the first activity</u>

We were excited when we read the pupils' reflection. Through their feedback, we could tell that pupils displayed different levels of inquisitiveness. Many said that they could overcome the difficulties encountered through discussing with their peers. Such quality interactions were also largely evident in the direct observations we made as the group discussions were on-going in class. While many claimed that they tended to be more patient and careful when doing their calculations, upon reflecting on our part, we felt that this could largely be due to the fact that pupils felt more comfortable and motivated working with the support of their peers. It is indeed a great satisfaction and encouragement to know that not only the GEP pupils could spot patterns and appreciate formulae, but our pupils could do likewise too! Through the activity, they understood the importance of using a formula to derive answers which involve big numbers. The feedback was positive and it gave us the encouragement and motivation to design the second mathematical investigative task for our pupils.

The flipside of this was that as the investigative task was carried out in class, we were practically torn between the two groups of students in each of our classes. While the focus group was enthusiastically discussing and posing questions to their peers and us, we also had to see to the needs of the rest who were doing their corrections. In each of our classes, 13 pupils were involved in the pilot study while the other 29 were tasked to do their corrections. We questioned ourselves whether it was ethical to deprive the latter of our attention. Hence, we made the decision to carry out the second investigative task outside the curriculum time. Activity 2 was thus done during the June school holidays.

Activity 2

The pupils in the focus group came back for 3 days during the holidays to design a ‘Math Trail’ for the Primary 3 pupils. They were instructed to form groups of 4 or 5 among themselves. Each group was given a set of template, instructions and the Primary 3 syllabus to design questions based on 8 locations in the school. Each location will form a ‘station’ in the ‘Math Trail’. *(refer to Appendix 1.4)* The school was being used as a ‘learning gallery’ as pupils ran around to look for suitable locations, such as the canteen, classrooms, basketball courts and staircases, to design authentic Math questions for the ‘Math Trail’. While the pupils were running around and formulating the questions, we videotaped the process and took pictures of them.

Analysis of the quality of the ‘Math Trail’ activities:

We walked around as facilitators to listen to the questions they raised in the course of their discussions and provided some feedback and suggestions on how the different locations in the school could be considered to pose Math questions to the Primary 3 pupils. There is a number pattern, similar to that of a ‘Snake and Ladder’ game, painted on the floor of our school parade square. Based on that, there were two girls from the focus group who asked each other, “Can you see any number pattern?” “Is there any question we can pose based on the pattern?” It is amazing to hear these questions coming from the two 12-year-old girls. Their conversation and the activity that they have designed demonstrated the internalisation of the important mathematical skill of pattern spotting by these pupils. (refer to Appendix 2.2) Another group came up with a set of questions based on pattern spotted for the red and white square floor tiles found at the school foyer. (refer to Appendix 2.3) One of the group members asked the other, “Do you know what is the shortest method to find the area of the white portion?” “Use the formula, Length x Breadth…” “Yup, but you can make use of a pattern, it’s faster.” These are certainly evidences of higher level of mathematical learning pupils could attain if, like Vygotsky had mentioned, teachers make it a point to stretch pupils’ developmental limits. (Mooney, 2000) In fact, we, the teacher researchers, actually needed some time to comprehend the pattern that was pointed out to us by the pupils!

When school reopened in July, we did a trial run of the ‘Math Trail’ with 40 pupils from a higher-ability Primary 3 class. The focus group, which actually designed the ‘Math Trail’, acted as facilitators to bring the Primary 3 pupils around to the various stations to answer the related questions. At each station, there were also 2 pupils from the focus group who took the role of station guardians to explain the questions to the Primary 3 pupils.

<u>Pupils' Reflection (2): After the carrying out the Math Trail with the Primary 3 students:</u>

Question: Do you think a Math Trail is important? Why/ Why not?

- Yes, it helps pupils to understand Math better in an interesting and fun way. The pupils can walk around the school so they will not feel bored. This is definitely better than sitting in class the whole day!
- Yes, as through this Math Trail, we could learn other things that are outside the textbook and in higher order.
- Yes, it improves the mathematical skills of both P3s and P6s.
- Yes. The Math Trail helps to boost my brain and sets me a challenge to design Maths questions for P3. We must also not be setting too hard questions for them.
- Yes, the Math Trail teaches us team spirit and Math skills. It teaches the importance of Math skills like plotting the graphs and spotting patterns. It also teaches us to look at Math in a different aspect.
- Yes. It helps us learn Maths at a higher-thinking level.
- I learnt to think from an imaginative perspective to think about how to set Maths question and how to teach other people in Maths.
- I think it is important as it helps students to learn better when they are having fun as it also helps them remember when they are having fun. We can also learn more things when we helped them.
- I think a Math Trail is important. We learnt new steps and difficult ways to solve a same question.
- Yes, the pupils can learn that Math is actually all around us. They can also learn something different from their textbooks. They can also learn in a more enjoyable way.
- Yes, it is. It helps the P3s to learn new concepts, learn how to be observant, learn how to find patterns and learn how to work fast.

Question: What were the difficulties you faced when designing the Math Trail?

- It was difficult trying to make the Trail creative, original and interesting so the students will not get bored. Another difficulty is making the Trail understandable and not complicated.
- To think of something to expand on and how to be creative.
- At first, we were unsure on how to design the questions and what kind of questions will fit the P3's standards.
- We faced some difficulties of students who had difficulties understanding our explanation.

Question: How did you overcome the difficulties?

- I tried to think in another dimension and see if there are any ways to make a trail that makes the students scratch their heads. Teamwork is also very important.
- We just used our imagination and tried to think what a P3 student would do.
- By asking help from teachers and discussing as a group to solve the problem.

- I thought about it, went to places in the school and discussed with my group members.

- We explained to them (the P3 students) a lot of times and asked them to be serious and try to understand. In the end, they managed to do the questions.
- Some of the questions were too difficult for the P3 students to understand.

Question: How did you feel when you had successfully designed the Math Trail?

- I felt a sense of accomplishment as I design problems and it is out of the textbook.
- I felt a sense of achievement.
- I felt extremely proud of myself.
- I felt that as a Primary 6 student, Not only did our juniors learn, we also learn some new steps. The problems were challenging too.

Question: State 3 things that you have learnt.

- I have learnt how to set good questions and teamwork is important. I also learnt how to answer questions confidently.
- We need teamwork to succeed. I learnt that patterns are important as it saves a lot of time.
- I learnt how to spot patterns. Teamwork is needed to succeed. I learnt how to create questions.
- Teamwork is very important. We must be patient towards the younger ones. We have to plan our timing properly in order to complete the Math trail.
- I’ve learnt to be more observant, to find patterns, teamwork spirit and even become creative.
- I have learnt how to set questions. I’ve learnt that teamwork can get results. I have learnt that we need to accept other people’s ideas.
- I cannot get distracted as I cannot finish my work on time. Math is not only about addition and subtraction but also patters. Teamwork is the most important during group work.
- Teamwork, knowledge, imagination

Question: If given a chance to improve on the quality of the Math Trail that you had designed, what would you improve on?

- I would like to improve on the questions as the P3s may not understand them.
- I would improve on making the questions easier to understand but I will increase the difficulty of the questions.
- I would not want to improve. I think this Math Trail is up to standard and would expose the P3s to even more challenging questions.
- I would improve on the timings as there was not enough time. I would improve on the questions too, not too difficult for the P3s.
- Make the questions simpler so that the P3s can understand.
- I would improve the creativity of it.

Analysis of pupils' feedback for the second activity and our passive observation of the Primary 3 'Math Trail':

After reading the pupils' reflections, we realised that the word "pattern" kept occurring. Pupils realised the importance of pattern spotting and have learnt how to spot patterns when designing the 'Math Trail' as well as in the previous activity on calculating simple and compound interests. They have even gone one step ahead to create mathematical questions based on the patterns that they have spotted. If pupils are frequently and continuously given practice in Mathematical Investigation, pattern spotting, as well as other problem-solving heuristics like deriving a formula, and thinking skills, will naturally be acquired by these high-achievers in Mathematics.

"Teamwork" is another high frequency word mentioned in pupils' feedback. The focus group attributed the success of the 'Math Trail' largely to teamwork. This confirmed our suspicion from the first activity that these pupils did place great emphasis on teamwork. While working in groups, pupils tended to be more vocal and reflective. We observed that after the trial run of the 'Math Trail' with the Primary 3 class, many, for one reason or another, wanted to improve on the questions that they have designed. Their enthusiasm was certainly one of the many factors that kept us going.

However, based on the feedback provided by the focus group and our observation of the Primary 3 pupils, the latter did have difficulty in seeing and understanding the patterns that pupils from the focus group have spotted. And that left us pondering, "Were the questions really too high order for them? Or were they just not exposed to that kind of 'pattern spotting' questions? Would they be mature enough or ready to handle that kind of questions? Or perhaps those activities were really more suitable for the older pupils?"

Significance of the project

Findings of the pilot study revealed that pupils understood the importance of teamwork and identification of patterns in problem-solving. The findings from the study are significant as they can be translated into problem-solving techniques that pupils will be equipped with for the later part of their lives. As teachers, we should not undermine our pupils' capability. We should constantly find ways to stretch them beyond their current level of expected development. Findings from the study have truly shown how much we, as educators, can enrich our pupils' learning by providing proper scaffolding to consciously stretch them beyond their developmental limits. If pupils are given frequent practice and constant exposures in Mathematical Investigation, the problem-solving ability becomes second nature to them. Thus, it could enhance an individual's capacity in management, leadership and other professional disciplines.

In conclusion, the preliminary theoretical construct can be regarded as an educational and developmental tool for personal growth and development.

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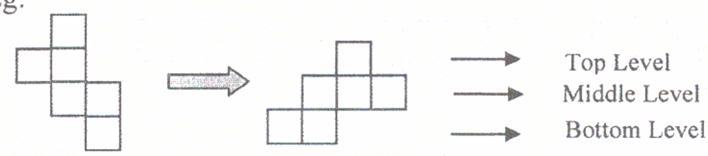
Appendix 1.1

N 2

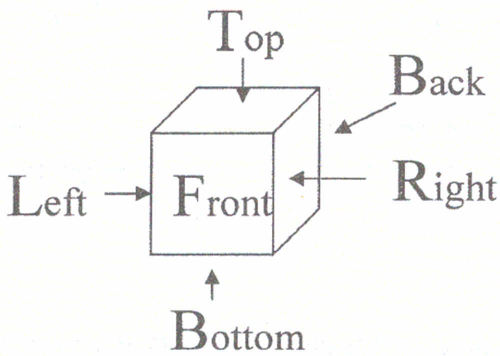
Name: ______________________ **Class:** _______ **Date:** __________

THE ROOM METHOD – A SYSTEMATIC APPROACH

Reviewing the 11 possible nets of a cube again, do you know of any systematic way to identify the faces of the cubes on each net? The method introduced here uses a cubic room as a reference for the cube. In any room, we can always find 4 walls, a ceiling and a floor. Hence, in order to orientate any nets, just arrange the nets into a form that shows just 3 horizontal levels. Eg:



Next, let's name the faces in accordance to how we view the cube externally.



Lastly, remember these three rules that will make the use of this method a breeze:

Rule 1: Opposite faces WILL NOT appear side by side with each other.

Rule 2: The Front Face must always be on the middle level.

Rule 3: In any of the nets, always start with the Front directly above the Bottom.

Appendix 1.2

Watch Your Money Grow !!!
(Part 1)
Topic: Simple Interest

Name: ____________________ Date: ______________
Class: ___________

2012 is the year when you start to have a holiday job. After months of backbreaking work, you manage to scrimp and save $1000 which you are going to put into a "Watch Your Money Grow" bank account. This bank promises you a 2% annual *simple interest rate* on your $1000. Being a Math whiz, you have decided to do some calculations before putting the money into the account.

Original Amount ($) ($P$)	Year (t)	Interest Rate in % (r)	Interest Earned	Accumulated Sum (A)
1000	1	2		
	2			
	3			
	. . .			
	50			

a) Can you see the relationship between P, t and r?
Derive a formula, in terms of P, t and r, to calculate the interest earned.

Working:

Ans: Interest Earned = ____________________________

b) Derive a formula, in terms of P, t and r, to calculate the accumulated amount, A.

Working:

c) Simplify your answer in (b).

Working: Ans: A = ___________________________

d) Based on the formula derived from (c), what is the accumulated sum in your bank account at the end of the 62nd year?

Working: Ans: Accumulated Sum = ___________________________

WATCH YOUR MONEY GROW
(PART 2)
Topic: Compound Interest

Name: ____________________ Date: __________
Class: ___________

After doing the first calculation on *simple interest,* you have decided to find out if you can get a better deal for your \$1000. So you surf the bank website again and find out that it has another type of "Watch Your Money Grow" bank account. It promises you a 2% annual *compound interest rate* on your \$1000. You have decided to do another set of calculation.

Original Amount deposited (P): \$1000

Amount at the beginning of each year(\$)	Year (t)	Interest Rate in % (r)	Interest Earned (i)	Accumulated Sum (A)	
1000	1	2	20	1020	P_1
1020	2	2			
	3				
	4				

a) Assuming the interest earned at the end of Year 1 is $i_1 = P \times t$, derive the formula, in terms of P and r, for P_1.

Working:

Ans: P_1 = ______________________

1

b) Based on the formula you have derived in (a), what is i_2 and thus, P_2 ?

Working: $i_2 = r \times P_1$ = ____________________ Thus $P_2 = P_1 + i_2$ =

c) Based on what you have done in (a) and (b), derive the formula, in terms of P and r, for i and P .

Working: i_3 = = ____________________ Thus P_3 = =

2

WATCH YOUR MONEY GROW
(PART 2)
Topic: Compound Interest

Name: ____________________ Date: __________
Class: ___________

After doing the first calculation on *simple interest,* you have decided to find out if you can get a better deal for your \$1000. So you surf the bank website again and find out that it has another type of "Watch Your Money Grow" bank account. It promises you a 2% annual *compound interest rate* on your \$1000. You have decided to do another set of calculation.

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1020	2	2			
	3				
	4				

a) Assuming the interest earned at the end of Year 1 is $i_1 = P \times t$, derive the formula, in terms of P and r, for P_1.

Working:

Ans: P_1 = ______________________

1

Appendix 2.1

P3 Topics

1. Whole numbers: 1 – 10 000

   - Addition & Subtraction: 1 – 10 000
   - Multiplication: Up to 10 times table
   - Division: a) Grouping & Re-grouping by 1-digit numbers
   - b) Division of 2-digit numbers by 1 digit number
   - Even & Odd Numbers

2. Money

- Converting cents to dollars & vice versa
- Addition & Subtraction of money

3. Bar graph

- Reading & drawing bar graphs

4. Time
   - Tell time by the clock
   - Tell duration in minutes / hours or hours and minutes
   - Convert hours & minutes to minutes & vice versa
   - Convert minutes & seconds to seconds & vice versa
   - Find the start or end time given the duration
   - Adding and subtracting time

5. Volume & Capacity
   - Measure in litres and millilitres
   - Compare volumes or capacities
   - Addition & Subtraction of volumes or capacities

6. Mass
   - Measure in kilograms (kg) and grams (g)
   - Compare masses
   - Addition & Subtraction of masses

7. Fractions
   - Numerator and denominator
   - Write the equivalent fraction of a given fraction with denominator not greater than 12.
   - Compare fractions using equivalent fractions method.
   - Compare fractions with the same numerator or denominator.

8. Length
   - Measure in metres (m) and centimetres (cm).
   - Compare length and distances.
   - Addition & Subtraction of length and distances.
   - Convert metres to centimetres & vice versa

- Convert kilometres to metres to seconds & vice versa

9. Area and Perimeter
   - Area of a figure formed by squares and half-squares in terms of square units.
   - Find the area of a composite figure in cm^2 and m^2.
   (Area = Length x Breadth)
   - Find the perimeter of a regular or composite figure.

Appendix 2.2

Station 6

Venue: Parade Square

Instruction:
1. Go to the parade square
2. Look for the painted tiles on the ground (the one that has ‘Go’ and ‘Home’)

Task:

(a) Fill in the numbers in the **white boxes** below. (‘Home’ has been changed to 48.)

						48
Go	**1**	**2**				
( )	( )	( )	( )	( )	( )	( )

(d)						

(b) Find the sum of numbers in first 3 columns and put it down in the brackets given.

(c) Using the pattern that you have spotted, fill in t[illegible] the b[illegible]

(d) [illegible] sequence of the numbers in the grey boxes, what happ[illegible]s to [illegible]he sum of numbers in the column? ____________________

Appendix 2.3

Station 1

Venue: Foyer

Instruction: Go to the foyer.

How many white tiles are there
in an area that is bounded by the red tiles?

N 2

Name: ______________________________ Class: _______ Date: __________

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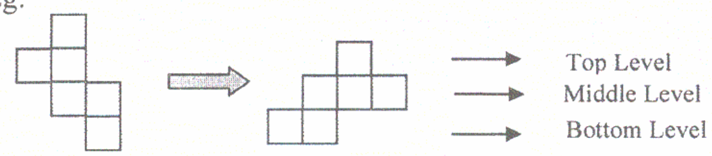
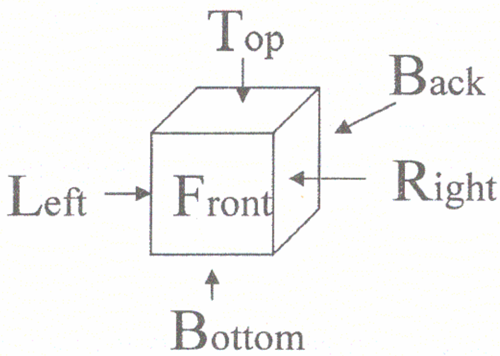
Reviewing the 11 possible nets of a cube again, do you know of any systematic way to identify the faces of the cubes on each net? The method introduced here uses a cubic room as a reference for the cube. In any room, we can always find 4 walls, a ceiling and a floor. Hence, in order to orientate any nets, just arrange the nets into a form that shows just 3 horizontal levels. Eg:



Next, let's name the faces in accordance to how we view the cube externally.



Lastly, remember these three rules that will make the use of this method a breeze:

- Rule 1: Opposite faces WILL NOT appear side by side with each other.
- Rule 2: The Front Face must always be on the middle level.
- Rule 3: In any of the nets, always start with the Front directly above the Bottom.

Task:

1) Find the difference between the perimeter of the white patch and the red outline. (The length of each square tile is 30cm.)

Ans: ________________ cm

2) Find the difference between the area of the white patch and that of the red tiles that bound it. Give your answer in **m**^{2}.

Ans: _______________ m^2

3) Find the fastest method to calculate the number of tiles in a white patch. Clue: There is a pattern in which the tiles area arranged.

Signature of Station Guardian

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