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Author(s)	Koay Phong Lee and Ng Swee Fong
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Communication Skills of Pre-service Elementary School Teachers

Koay Phong Lee & Ng Swee Fong
National Institute of Education

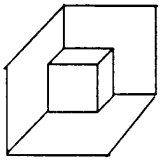
Introduction

Communication and language play an important role in the learning of mathematics. In Singapore, the Ministry of Education has identified "the use of mathematics as a means of communication" as one of the aims of mathematics education in schools. In the US, the Curriculum and Evaluation Standards for School Mathematics (Standards) also identifies learning to communicate mathematically as an important goal and envisions a classroom where pupils talk, write and present their ideas mathematically. While in the UK, it is pointed out that the main reason for teaching mathematics is its importance in the analysis and communication of information and ideas, and not the mere manipulation of numerical or algebraic symbols.(HMI, p.2, 1985).

In primary school geometry classes, pupils learn about basic shapes and their properties. They also learn to use correct vocabulary, precise definitions and propositions to describe the relationships between geometric images. Pimm (1995) suggests learners of geometry can use language in a way to achieve control over geometric images that they encounter in their learning. They can describe what they see, what they want to see, as well as what they want others to see. Listening to others talking about what they see can further develop control. In addition, learners can use language to create new images that are formed as a result of the interaction between their imagination and their physical world.

The use of language is at the core of geometry instruction, particularly at the primary school level. In primary mathematics classrooms, pupils seldom question the language used by their teacher. When their understanding do not match that of their teacher, they tend to watch and listen, try to guess at the meaning rather than challenge their teacher. Hence, teachers must be precise in describing what they want their pupils to 'see' and be aware of the subtle power of the words they use in instruction.

For example, teachers, describing the following diagram, may choose to say "I can see a cube in the corner." rather than "You can see a cube in the corner." Their choice suggests that they are aware their pupils may not see the same thing as they do.



Effective communication involves competent use of precise language to convey thoughts and images. According to Kessler (1987), the four competences necessary for effective mathematics communication are grammatical competence, discourse competence, sociolinguistic competence and strategic competence.

- **Grammatical competence** refers to the ability to use the correct vocabulary and syntax in the mathematics communication.
  E.g. using the term *cuboid* instead of *box-like solid.*
  Using uppercase letters to name a line segment or a lowercase letter to identify a line.

- **Discourse competence** refers to the ability to recognize and differentiate between the representative function and the directive function of mathematics discourse. The former concerns descriptive information and the latter the directions of the information to be acted on. For example, in the following two instructions:

  "Draw a square of side 2 cm."
  "Draw a square."

  Draw a square serves the directive function while *of side 2 cm* serves the representative function of the discourse. The two instructions convey different images. The former implies a particular square while the latter implies any square. Inability to differentiate the two is an instance of discourse incompetence.

- **Sociolinguistic competence** refers to the ability to use appropriate personal and cultural experiences to convey information and interpret correctly the message communicated.
  For example,

  "The yard markings on a football field are parallel.
  Draw 2 lines that are parallel."

  Not having the cultural information about the meaning of the 'yard markings on a football field', most pupils in Singapore, unlike their US counterparts, would not understand the message.

- **Strategic competence** refers to the ability to decode a mathematical message. In this study, it refers to the ability to encode images and use words effectively to convey images. Strategic competence is related to grammatical competence, discourse competence and sociolinguistic competence.

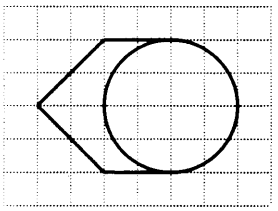
This paper examines the communicative competence in mathematics of pre-service elementary school teachers.

The study

This exploratory study reports on the pre-service teachers' competent use of language to convey a static geometric image. The subjects were 48 Postgraduate Diploma in Education (Primary) students at the National Institute of Education. They were told to work in groups of four to prepare a set of directions for drawing a given figure.

The task

"Imagine that you are talking on the telephone to your friend Mary.
You want her to draw a figure. Your friend cannot see the figure.
Write a set of directions so that she can draw the figure exactly as shown below."



The classroom situation may not lend authenticity to this task. In normal situations, various modes of communication such as language, gestures and drawings would be utilized to convey the information. However, as handheld phones is a common phenomena and the use of precise language is the only option for communicating information, we find the task fits the purpose of this study.

Findings

The 12 sets of instructions prepared by the pre-service teachers were examined in terms of their mastery in the four areas of competence.

Five sets (42%) of instructions ignored the square-grids and began with the instructions to draw the circle. In all 12 cases, instructions for drawing the circle were given before the horizontal lines, followed by the construction of the two slanting lines. Only one set (8%) of instructions made reference to the 'whole' picture.

Grammatical competence

A common error the pre-service teachers made was the incorrect use of mathematical vocabulary, especially in the units for linear measures and the concept of point. Among the seven sets of instructions that made reference to the square-grids, two gave instructions to draw a circle of radius 2 square units.

"Draw a circle with diameter of 4 square units.
From the topmost point of the circle, draw a straight horizontal line, measuring 2 square units, to the left." (R5)

"Use a square paper (6 by 8).
Draw a circle with radius of 2 squares." (R12)

The grid lines seemed to be the salient feature of the figure and cause these pre-service teachers to ignore their knowledge on linear measures and use incorrect unit in their instructions. In addition, one group of pre-service teachers (R12) referred to the square grid paper incorrectly as square paper.

In two cases, the term *point* and the letters indicating the points were used interchangeably. Consequently, the instructions for erasing the letters indicating the points were given as follows:

"Rub off the points A, B, C." (R2)
"Erase off all the points." (R4)

Discourse competence

Effective discourse involves the proper use of directives and descriptive information. Four of the seven sets of instructions that made reference to the square-grids showed instances of discourse incompetence. The instruction to draw a circle was given without reference to the location of the centre of the circle (R4, R5, R11, R12). These pre-service teachers tended to concentrate on giving the directives and ignored the descriptive aspect of the discourse.

"Get a square grid paper.
Draw a circle with diameter of 4 square units.
From the topmost point of the circle, draw ..." (R5)

"Take out a 1-cm square grid paper. Draw a circle of diameter 4 cm.
From the centre of the circle, move up ..." (R4)

Here are another two instances of discourse incompetence. In the first instance, the word *point* was used to refer to the 'distance of the point from the centre'. In the second instance, the point on the line to be joined to the dot was not explicitly stated.

"Draw a point to the left of the centre of the circle.
The point should be twice the radius of the circle.' (R10)

"Join that dot to the horizontal line above the circle.
Join the same dot to the horizontal line below the circle." (R9)

Sociolinguistic competence

Here, some pre-service teachers showed instances of sociolinguistic competence. They spoke of the two points on the circumference of the circle in the figure as the North and South poles of a circle, and most listeners would have no difficulty identify the points on the circle.

"From the north and south poles of the circle, draw a straight horizontal line to the left.' (R10)

"Draw a 2-unit horizontal line to your left, from the top of the circle (North pole). Mark the end of the line point A." (R7)

Strategic competence

Here are 2 sets of instructions that show strategic competence in translating images to words. One involves the idea of **coordinates**. (R1)

Draw a 6 x 8 1-cm square grid paper.

Label vertical axis from 0 to 6, starting from the bottom.
Label horizontal axis from 0 to 8, starting from the left.
Draw a circle of radius 2 cm with centre at (5, 3)
Draw a straight horizontal line from (3, 5) to (5, 5).
Draw a straight horizontal line from (3, 1) to (5, 1).
Draw a straight line to join the point at (3, 1) to (1, 3)
Draw a straight line to join the point at (3, 5) to (1, 3)

The other (R3) uses the representative aspect of discourse at appropriate intervals for the listener to reflect on what have been drawn.

Draw a circle of diameter 4 cm.
Draw the vertical diameter of the circle.
Use this line as the right side of a square and draw a square of side 4 cm.
Your square should be on the left side of the circle
Name the other two corners of your square C and D.
Now your square should be called ABCD in order.
Mark the midpoint of AD. Call this M1.
Mark the midpoint of BC. Call this M2.
Mark the midpoint of CD. Call this M3.
Now join M1 to M3.
Join M2 to M3.
Erase the line AB
Erase the line CD but do not erase the point M3.
Erase the line from M1 to the point where D was.
Erase the line from M2 to the point where C was.

There was also a group of pre-service teachers' (R4) who concluded their discourse with a descriptive statement, providing the listener a means to reflect on the image drawn.

"The figure drawn should be symmetrical upon a horizontal line of symmetry that passes through the centre of the circle." (R4).

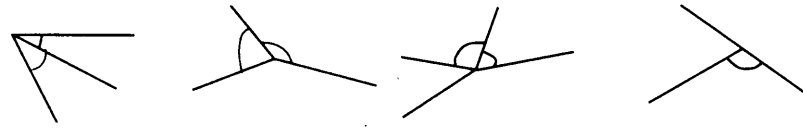
Conclusion and implications

One of the aims of the mathematics methods course is to develop the ability of the pre-service teachers to communicate mathematical ideas orally and in writing. This exploratory study indicates the need to increase the competence of pre-service teachers in mathematics communication. More opportunities to listen as well as to speak mathematics must be given to pre-service teachers to increase their understanding of mathematical ideas, develop their skills and understanding of the importance of discourse. Hopefully, they can then transform their experiences into practice and foster communication skills in the classrooms.

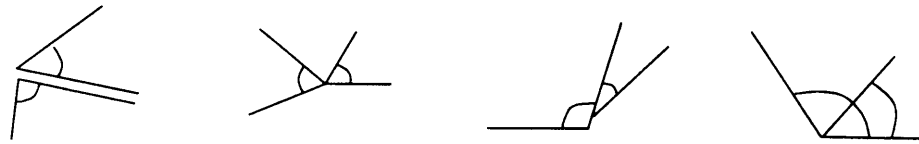
The following are some approaches that mathematics methods instructors may use to foster communication in geometry.

- **What is a ....?**

Identify a concept and have the pre-service teachers use figures to present the examples and non-examples of the concept. Then, have the pre-service teachers describe the commonalities among the examples and verbalise the concept.
E.g., For the concept of *adjacent angles*, the following figures may be drawn.

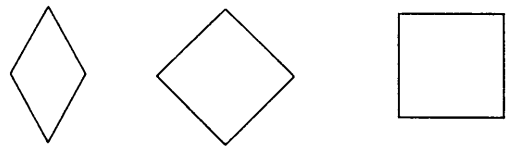


These are adjacent angles



These are not adjacent angles

- **What do you know about ...?**
  Have pre-service teachers write what they know about a concept and use the responses to start the discussion. Make sure that correct vocabulary is used.
  e.g., Draw a circle and ask, "What do you know about this shape?"
  or, Draw the following figures and ask, "How are these shapes related?"



- **What can you see?**
  Conduct a 'poster' lesson, have a pre-service teacher sit on the 'hot seat' in front of the room. She has to look at the poster and 'say what she see' to the rest of the class without 'pointing'. This will force the pre-service teacher to focus on the use of precise language to convey what she sees. The class can then question their colleague in the 'hot seat' and work to refine the mathematical language used to convey the desired meaning. Jaworski (1985) has given an account of such a session with a middle-school class of pupils.

  Instead of a static image such as a poster, have pre-service teachers create images through the use of words alone. Have the pre-service teachers close their eyes, listen to a set of instructions and draw their mental pictures. Since mental images are inherently personal, these pre-service teachers, after comparing their drawings, will realise that something they had assumed 'taken as shared' was in fact, not (Beeney et als, 1982).

The activities mentioned in this paper encourage the pre-service teachers to draw on their mathematical experiences in explaining what they see, and create a comfortable learning environment that encourages discussion and cooperative learning. These activities promote the perception of projective seeing, making the pre-service teachers aware that what they 'see' is probably different from the others, and often they are not able to 'see' what the others 'see'. The activities highlight the importance of the use of precise and appropriate language to communicate thoughts and images. Since what is going on in their heads is hidden from the others, pre-service teachers cannot assume that their listeners, particularly their pupils in future, can fill the gap from the context or from previous knowledge.

Mathematical communication is at the core of mathematical teaching and learning process. Communication in mathematics classrooms may take three different modes: enactive, iconic and symbolic. In the classroom of today, iconic modes include the static images presented in printed texts or drawn on transparencies and whiteboard as well as the dynamic images found on calculators and computer monitors. Teachers can never know exactly what their pupils see in these images, but language can be used to help covey what they want pupils to see. The activities cited in this paper may be modified for use in classrooms and assist teachers to gain insight into pupil's thinking and guide them in their instruction.

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