International Journal of Mathematics And Its Applications
Vol.2 No.2 (2014), pp.47-58
ISSN: 2347-1557(online)

Maximality of Circular Area: An Activity Oriented Learning

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Abstract : All we know that, by the nature of the subject, mathematical concepts are very abstract, concise and powerful in the sense that it can be applied in problems arising out of diverse field of our study. But it is observed from the direct interaction of students, their performance in examinations etc. that a significant amount of them are lacking of understanding the basic concepts of mathematics, though they do some mechanical approach towards the subject and as a consequence of which, gradually their interest towards the subject disappear. This is a great loss of a country as in the modern era, science and technology have a pivotal role and hence there is a great demand for scientifically skilled manpower and the scientific outlook is best nurtured from the logical activity i.e. in other words, mathematical activity of our brain. But it is a matter of pity that sufficient care has not been taken in the teaching-learning process of mathematics at school level. In fact research has documented that, traditional theoretical methods of teaching supplemented by activity oriented method, resulted a significant improvement of the performance level of the students. Thus development of standard books of school mathematics with adequate number of activity examples and exercise is greatly needed. In this context, in this paper,

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AMS Subject Classification: 97C70, 97D40, 97G30.

the author has presented different activity oriented examples concerning the circle is the shape with the greatest area than all other closed curves when the perimeter is fixed.

Keywords : secondary level, learning mathematics, mensuration, circle, solid object, circumference / perimeter, area, volume, activity.

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1 Introduction

The objective of the mathematics education at school level is to develop logical mind-set of the children. But it is a hard reality that we are far from our goal as documented from the percentage of the failure of students in different Board examinations and not to choosing science as their discipline of higher studies. The root cause behind this is their distaste in mathematics. In fact mathematics is a subject of abstract concepts built up in strictly logical framework. So teaching of this fundamental subject plays a vital role, specially, in school mathematics. The teaching methodology must have a proper blend of both theoretical and activity oriented approach so that the young mind finds a pleasure of visualizing the abstract ideas into real life situations.

In this context Psychologists, mathematicians, National Curriculum Framework[9], National Focus Group on Teaching of Mathematics of National Council of Educational Research & Training (NCERT)[10] has stressed on instruction aids and real direct experience for strengthen learning (Chakraborty, S.[2], Mondal, Dr. V. and Kar, Dr. R.[7], Roy, S.[12], Donna, H. H.[4]). Research has documented that children in early grades learn mathematics more effectively when they use physical objects in their lessons (Carmody, L.[1]; Fennema, E.[5]; Jamison, D., Suppes, P., and Wells, S.[6]; Suydam, M. and Higgins, J.[14], Rossnan, S[11], Donna H. H.[4], Selvam, Sk. P.[13]).

The use of both manipulative materials and pictorial representations is highly effective whereas symbolic treatments alone are less effective. But it is interesting to note that the great mathematician Bhaskara (1114-1183) had studied the mensuration through activity based approach in the ancient period of India (Chakraborty, S.[3]). Therefore, it is really true that there is an importance of this approach for better understanding of mathematical concepts.

At present, the status of implementation of the activities based mathematics learning in India is poor. In this regard, S. Anandalakshmy & Bala Mandir Team (2007) said in 'A Report on an Innovative Method in Tamil Nadu' on Activity Based Learning that innovative methods which engage the children and enable them to achieve mastery over school-related competencies and skills can be located here and there. However, they are small in scale and number in India.

Through in the text books of mathematics (including the book of mathematics through work) of West Bengal Board of Primary Education (WBBPE) and West Bengal Board of Secondary Education

(WBBSE) up to upper primary level some activity oriented problems have been considered but these are too in adequate. Even, in some presentations of these activities, there are apparently some ambiguities. There is no scope for alternative activities considering the target population. Even, in the text books of mathematics of class-IX & X standard of WBBSE, activity oriented learning has not been considered. On the other hand, generally, the teachers as well as the learners do not get readily available resources of activity oriented problems. So, the author as a mathematics teacher at secondary level under WBBSE feels the need to develop different activity problems in school mathematics and present them sequentially considering the learners' ability level, target group etc.

In this article, author has presented below four activities for finding, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves which will encourage the learners to consolidate their knowledge and to practice mathematics joyfully, and surely, they will relish the simplicity & the logical beauty of the subject.

2 Objective of the Study

The aim of this study is to develop various learning activities for finding, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves.

3 Activities

Activity-1

Verifying, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves on a graph paper/gridlines sheet.

Requirements : Graph sheet/ gridlines sheet, geometrical instrument box.
Mode : Pair group.
Strategy : Learning through activities.
Objective of the development : Cognitive development.

Activity Follows:

Stage-I

The teacher will do the following activity with the help of the learners.

1. After showing a gridlines sheet/graph sheet, the teacher will ask the learners to choose a suitable unit of area?

2. Showing a region made of square regions, the teacher will ask the learners-how many squares are in the region?

3. Showing a region made of square and triangular halves of the squares, the teacher will ask the learners-how many squares are there (taking two triangular halves as a full square)?

Stage-II

The learners will do the following activities with the help of the teacher, if needed.

Each pair group:

1. Takes a graph sheet/ gridlines sheet.

2. Draws a closed curve like *triangle* whose perimeter is 22 cm (say) on the graph sheet/gridlines sheet. (pl. see-Figure1)

3. Identifies unit square and half of the unit square.

4. Counts the no. of unit squares and halves of the unit squares.

5. Finds the total area after counting the total unit squares and halves of the unit squares.

6. Draws a *rectangular closed curve* whose perimeter is 22 cm. (pl. see-Figure 2)

7. Identifies unit square.

8. Counts the no. of unit squares.

9. Finds the total area after counting the total unit squares.

10. Draws a *square* whose perimeter is 22 cm. (pl. see-Figure 3)

11. Identifies unit square.

12. Counts the no. of unit squares.

13. Finds total area after counting the total unit squares.

14. Draws a *pentagon* whose perimeter is 22 cm. (pl. see-Figure 4)

15. Identifies unit square and marks half of the unit square.

16. Counts the no. of unit squares and halves of the unit squares.

17. Finds total area after counting the total unit squares and halves of the unit squares.

18. Draws a *circle* whose perimeter is 22 cm. (pl. see-Figure 5) (taking radius 3.5 cm)

19. Identifies unit square and marks half of the unit square.

20. Counts the no. of unit squares and halves of the unit squares.

21. Finds total area after counting the total unit squares and halves of the unit squares.

22. Compares the areas of the calculated out the figures: triangle, square, pentagon and circle.

All pair groups:

1. Compare their results.

The work is illustrated below:

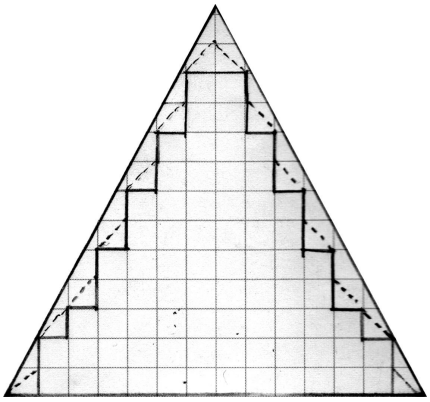

Figure 1: Triangle

No. of complete squares= 74

No. of half squares= 14

Total Area $= (74 + 14 \times \frac{1}{2})$ sq. units

$= (74 + 7)$ sq. units= 81 sq. units

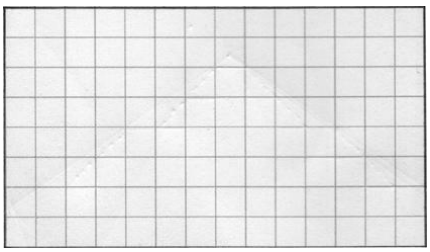

Figure 2: Rectangle

No. of complete squares= 112

Total Area = 112 sq. units

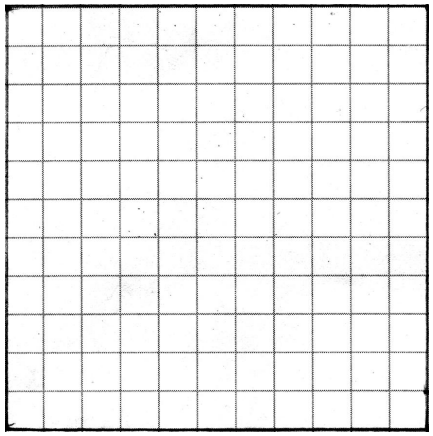

Figure 3: Square

No. of complete squares= 121
Total Area= 121 sq. units

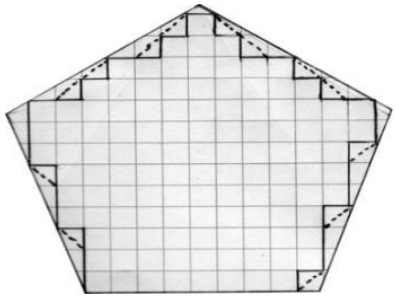

Figure 4: Pentagon

No. of complete squares= 116
No. of half squares= 13
Total Area= $(116 + 13 \times \frac{1}{2})$ sq. units = $(116 + 6.5)$ sq. units= 122.5 sq. units

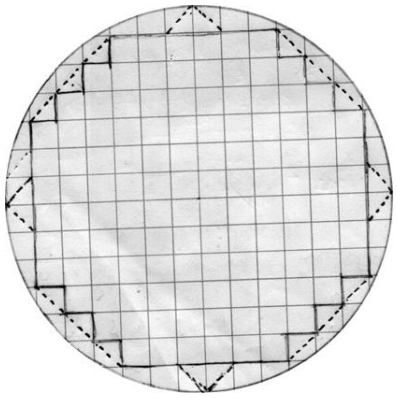

Figure 5: Circle

No. of complete squares= 120
No. of half squares= 20
Total Area= $(120 + 20 \times \frac{1}{2})$ sq. units = $(120 + 10)$ sq. units= 130 sq. units

Since 81 sq. units < 112 sq. units < 121 sq. units < 122.5 sq. units < ... <130 sq. units,

so with the same perimeter, triangular area < rectangular area < square area < pentagonal area < ... < circular area.

Activity-2

Verifying, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves on mm division graph paper.

Requirements : mm division graph paper, geometrical instrument box.
Mode : Pair group.
Strategy : Learning through activities.
Objective of the development : Cognitive development.

Activity Follows:

Stage-I

The teacher will do the following activity with the help of the learners.

1. After showing a mm division graph paper, the teacher will ask the learners about the units of area like cm square, half cm square, mm square, half mm square.
2. Showing a region within which there are cm squares, triangular halves of cm squares, mm squares, triangular halves of mm squares, the teacher will ask the learners to find the area of the region?

Stage-II

The learners will do the following activities with the help of the teacher, if needed.

Each pair group:

1. Takes mm division graph paper sheet.
2. Draws a closed curve like *triangle* whose perimeter is 22 cm (say) on the graph sheet.
3. Identifies cm square, half cm square, mm square, half mm square.
4. Counts the no. of cm square, half cm square, mm square, half mm square.
5. Finds the total area after counting the total cm square, half cm square, mm square, half mm square.
6. Draws a *rectangular closed curve* whose perimeter is 22 cm.
7. Identifies cm square.
8. Counts the no. of cm square.
9. Finds the total area after counting the total cm square.

10. Draws a *square* whose perimeter is 22 cm.
11. Identifies cm square, half cm square.
12. Counts the no. of cm square, half cm square.
13. Finds total area after counting the total cm square, half cm square.
14. Draws a *pentagon* whose perimeter is 22 cm.
15. Identifies cm square, half cm square, mm square, half mm square.
16. Counts the no. of cm square, half cm square, mm square, half mm square.
17. Finds total area after counting the total cm square, half cm square, mm square, half mm square.
18. Draws a *circle* whose perimeter is 22 cm. (taking radius 3.5 cm)
19. Identifies cm square, half cm square, mm square, half mm square.
20. Counts the no. of cm square, half cm square, mm square, half mm square.
21. Finds total area after counting the total cm square, half cm square, mm square, half mm square.
22. Compares the calculated areas of the figures: triangle, square, pentagon and circle with a given perimeter.

All pair groups:

1. Compare their results.

Activity-3

Verifying, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves using different shapes of cylindrical objects where the perimeters of the base of each object are same.

Requirements : Five cylindrical objects (like measuring cylinder) whose bases are triangular, rectangular, square shaped, pentagonal and circular with equal perimeters, water, measuring cylinder, scale.
Mode : Pair group.
Strategy : Learning through activities.
Objective of the development : Cognitive development.

Activity Follows:

Stage-I

The teacher will do the following activities with the help of the learners.

1. The teacher will collect five cylindrical objects of different shapes which are mentioned in the requirements.

2. After showing these cylindrical objects, the teacher will ask the learners about i) the volumes of them ii) relationship between the areas of the bases and volumes of these objects.

Stage-II

The learners will do the following activities with the help of the teacher, if needed.

Each pair group:

1. Takes the five cylindrical objects (like measuring cylinder) whose bases are triangular, rectangular, square shaped, pentagonal and circular with equal perimeter.

2. Pours these five cylindrical objects with the water of same volume (using measuring cylinder).

3. Observes the height of the water level of each cylindrical object by scale.

Activity-4

Verifying, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves using cylindrical shaped polythene pipe.

Requirements : Measuring Cylinder, cylindrical shaped polythene pipe, water.
Mode : Pair group.
Strategy : Learning through activities.
Objective of the development : Cognitive development.

Activity Follows:

Stage-I

The teacher will do the following activities with the help of the learners.

1. After showing a measuring cylinder, the teacher will ask the students how to measure the volume of liquid contained in this cylinder.

Stage-II

The learners will do the following activities with the help of the teacher, if needed.

Each pair group:

1. Takes cylindrical shaped polythene pipe.
2. Pours about half of the cylindrical pipe with water.
3. Observes the height of the water level in the pipe.
4. Presses slowly the polythene cylinder in such a way that its base becomes non circular.
5. Observes the heights of the water levels.
6. Considers the relationship between the heights of the water levels and areas of the bases of the cylindrical pipe.

4 Conclusion

1. Four illustrations of activities for verifying that, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves have been developed and presented sequentially in this paper. None of these activities has been appeared in the text books of WBBSE. These activities have not been stressed in the text books of NCERT. Therefore, it is a gap both in the syllabus and in the text books of school mathematics.
2. Through the illustrations of activities, it has have been shown that with a given perimeter, triangular area $<$ rectangular area $<$ square area $<$ pentagonal area $< \ldots <$ circular area.
3. This study will help the teachers and the students to show that for a fixed perimeter, circle is the curve enclosing greatest area among all other closed curves through the activity based learning.
4. Collection of multiple numbers of activities will help the teachers to choose the appropriate activity for the learners considering the learners' ability levels, needed time, availability of working materials and class room ambience etc.
5. This study will also help to (a) prepare a proper syllabus; (b) develop a good text book; (c) improve the quality of teaching-learning process of mathematics.
6. These type of activities will help the children to enjoy learning mathematics so that the phobia in mathematics will be reduced and stop the drop out of students.
7. Special interest towards mathematics can be enhanced which will be helpful for entire science education.

5 Further Study

All activities may be applied on large number of samples of class-V, VI etc for verifying that, for a fixed perimeter, circle is the curve enclosing greatest area than all other closed curves.

Acknowledgement(s) : I am thankful to Prof. S.K. Samanta, Professor-in-Charge, Centre for Mathematics Education, Visva-Bharati for his continuous support in course of preparing this paper.

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This paper has been presented in the National Seminar on 'Treasure of Tranquility: Philosophical Legacy of Indian Education' held at Department of Education, Vinaya Bhavana, Visva-Bharati, Santiniketan, West Bengal, India on 3rd – 4th February, 2014.