Exploring the Impact of Problem-Based Learning Approach on Students' Performance in Solving Mathematical Problems under Circles (Geometry)

ABSTRACT

This research work aimed to explore the impact of Problem-based Learning (PBL) approach of teaching mathematical problem solving in circles under geometry at Wiawso College of Education. The research design adopted for the study was action research and its main objective was to improve practices. The target population was level 100 students of the College and the population size was four hundred and nineteen (419) whilst the sample size was one hundred (100), comprising two (2) classes, which was selected based on purposive sampling. The instrument used for the study was tests. In the pre-intervention stage, a pre-test was used to identify the weaknesses of the students before the interventional strategies were applied. A post-test was conducted to evaluate the intervention strategies. The quantitative data was then analyzed using paired sample t-test, the means and their respective standard deviations, were calculated. The post-test mean scores of 21.40 (Standard deviation of 2.37) and 20.10 (Standard deviation of 2.85) is significantly higher than the pre-test mean scores of 7.40 (Standard deviation of 2.84) and 7.60 (Standard deviation of 3.53). The results of the study clearly showed that, there has been a remarkable improvement in the students' performance in solving mathematical problem in circles under geometry, when they were taught using problem-based learning approach. A quiz was conducted six weeks after the post-test using the same test items to check students' retention of the concept. The quiz mean scores of 21.90 (Standard deviation of 1.91) and 20.30 (Standard deviation of 2.58) is not significantly higher than the post-test mean scores of 21.40 (Standard deviation of 2.37) and 20.10 (Standard deviation of 2.85). The result showed that the students' retention of the concept had been exceptionally good. The study recommended that teachers should be encouraged to employ problem-based learning approach in teaching geometry.

Keywords: Problem-based learning; problem solving; circles; geometry; teaching and learning.

1. INTRODUCTION

Mathematicians and math students alike can better realize and comprehend the space, shape, and orientation of various bodies and objects in this universe with the aid of the geometry idea of the circle [1]. In other words, geometry offers a full understanding of the world we live in. The concept of geometry helps pupils enhance their spatial awareness, intuition, visualization skills, and problem-solving abilities [2]. According to studies, geometry is useful and relevant in both the workplace and daily life [3,4]. Furthermore, understanding geometry is a must for courses in science, arts, and technology [4,5]. This implies that mathematics has been a driving force behind technological development in the twenty-first century [6,7]. This calls for equipping students with better thinking skills and learning abilities.

The requirement to raise pupils who can adapt in rapidly changing contexts presents educators with a greater task than ever before in this era of tremendous technological advancements and constant change in many facets of life. This suggests that teaching activities, learning tasks, and the standards for evaluating learning outcomes all need to be modified. In other words, a paradigm shift is required so that the teacher's function changes from knowledge provider to learning facilitator and the student's role transforms from information receiver to active participants in the classroom [8].

The teacher-centered approach (lecture-based instruction), which is the traditional method utilized by the majority of mathematics teachers in Ghana, has negatively impacted effective mathematics learning at various educational levels [9]. As a result, several Ghanaian secondary school students struggled with geometry in general and performed poorly on circles. The issue has been noted in a number of Reports of the Chief Examiner for the West Africa Examination Council (WAEC), which highlighted geometry as one of the topics that students struggle with [10,11]. The situation was not different in the colleges of education as well. The performance of level 100 students of Wiawso College of Education in area of circles under geometry was below expectation. Most of these students' retention and confidence to accept or respond to a task that involves circle was not encouraging; this problem was identified, during a review to consolidate some of the topics treated under geometry, specifically, circles at the Senior High Schools.

Research have suggested that students lack of comprehension in circles in geometry and poor performance in mathematics in general is as a result of teachers neglect and improper handling of the topic [3,12,13]. According to other studies, the issue is caused by students' inadequate conceptual grasp of geometry at the elementary school level [9,13], which suggests that, the instructional strategies used by the teacher have an impact on the learners' cognitive, emotional, and psychomotor development.

However, with the passage of time, there have been substantial changes to the methods of instruction and education. There are now more options for teaching and learning than just traditional classroom settings where one person delivers the lesson and a group of students listen [14]. The problem then is what must be done to assist the pupils to improve upon their understanding, knowledge and skills as well as acquiring new principles to solve mathematical problems in circle under geometry. Therefore, this research was aimed at using the problem-based learning approach as an effective tool to improve pupils understanding, knowledge, skills and performance in solving mathematical problems in circles under geometry.

1.1 Research Question

The under listed questions guided the researchers to undertake this study;

1. To what extent will the use of problem-based learning approach improve students' achievement in circles under geometry?
2. To what extend will the problem-based learning approach improve the retention of mathematical concept among students in circles under geometry?

2. LITERATURE REVIEW

The need to apply mathematics to solve everyday life problems calls for the introduction of problem solving as a component of the mathematics curriculum [15]. A problem-solving curriculum for all levels of education was advocated by Ghana's Education Reform Committee in 2018. In 2019, this curriculum became law. It specifically recommended using suitable mathematical problem-solving techniques for teaching and learning mathematics [15]. Therefore, one of the key goals of teaching mathematics in Ghanaian schools is to assist pupils in learning problem-solving skills. Additionally, it places a strong emphasis on presenting mathematical concepts to pupils through real-world examples.

In every classroom, students are expected to learn mathematics concepts while acquiring processed skills, positive attitudes and values and problem solving skills [16]. Many different teaching methods, from teacher-centered ones to ones that are more student-centered, have been recommended for use in mathematics classrooms. According to a study by Arthur, Asiedu-Addo, and Assuah [17], implementing contemporary pedagogical strategies that motivate students to learn can improve conceptual understanding.

The study's theoretical framework was the Problem-Based Learning (PBL) theory. The progressive movement, including John Dewey's belief that teachers should support students' intrinsic desire to learn via inquiry and creation, is where PBL first emerged. In contrast to traditional teacher-centered classrooms, Roh [18] argued that problem-based learning environments place a higher value on an instructor's instructional abilities. PBL requires students to hone their critical thinking and problem-solving abilities. PBL is an illustration of a teaching strategy where students use their prior knowledge to address problems and learn new stuffs in the process. PBL encourages students to actively participate in information analysis for a particular task, which increases the likelihood that it will inspire and motivate them to study.

As the name suggests, problem-based learning starts with a challenge that needs to be overcome [19]. The purpose of learning is to actively and creatively involve students in group projects and their own knowledge, not simply reproduce, recollect, and retain information that has been passively received. We can personalize lessons to students' interests and use those interests to engage them because we are aware of their experiences outside of the classroom [20]. A teaching and learning strategy that encourages reflection outside of the classroom in daily life is one that is consistently successful in formal education, according to Hyun *et al*. [20]. Students are given activities to complete rather than lessons to learn. Additionally, learning happens naturally since doing calls for thinking or purposeful connection-making. Individual, autonomous, self-directed learning gives one the freedom to pick their learning strategy and the pace at which they want to finish it.

The scope of the modern educational system has expanded to incorporate more active learning strategies that enable students more opportunity to explore on their own outside of the instructor-led curriculum. The most important thing a teacher does is help students develop their own learning habits. The creation of a creative and practical learning environment through the student-centered active learning process known as problem-based learning, in which the teacher merely serves as a guide or facilitator, is the focus of the modern educational system, according to Alharbi and Cuihong [21]. PBL enhances students' learning outcomes by promoting their abilities and skills in applying knowledge, solving problems, practicing higher order thinking, and self-directing and reflecting on their own learning [22]. In a PBL setting, students receive and develop higher-level abilities like critical thinking and problem solving while drawing knowledge from their own real-world experiences and gaining specific understanding about their own learning to enhance performance [23,24].

3. METHODOLOGY

3.1 Research Design

Action research was the design employed in this study because it deals with small-scale intervention, which is suitable for a one-classroom setting in the context of which this study was conducted. According to Mills and Geoffrey [25], action research is the study concerned with immediate solution to a local problem. Thus, the process through which practitioners make an effort to conduct scientific research on their problems in order to guide, modify, and examine their decisions and actions to remedy the situation. It is also a comprehensive investigation carried out by instructors to understand more about how their schools operate, how they teach, and how effectively their students learn [26]. This design allows the teacher, through observation, listening, evaluating, questioning and being interested in developing one's own knowledge, to determine the efficacy of his/her teaching [27]. The purpose of gathering this data is to gain insight, foster reflective practice, make impactful improvements to the learning environment in schools, as well as to educational practices in general, and enhance student outcomes.

3.2 Population and Sampling

The study was conducted at Wiawso College of Education in the Sefwi Wiawso municipal. The college has a population of thousand five hundred and twenty-three (1523) students. Purposive sampling method was employed for the sample selection. The target population for the research was the level 100 Bachelor of Education (B.Ed) Students of Wiawso College of Education. There are Four hundred and nineteen (419) of the students in the level 100 (first year). The research was conducted in SM 1 and SM 2 classes with students totaling one hundred (100) comprising 68 males and 32 females. The average age of the class was seventeen (20) years and the students came from various regions in Ghana.

3.3 Instrumentation

The instrument used was test items. The test comprised of both pre-test and post-test to gather information about the learners' achievements in tackling mathematical problem related to circles under geometry. The instrument was well designed to assist with basic data collection, presentation, interpretation, and organization. In addition, the pre-test and post-tests were used to measure the students' success before and after the intervention.

3.4 Intervention Activities

Due to the poor performance of the students in the Pre – test, the challenges they encountered when solving mathematical problems in circles had to be addressed. The authors outlined series of instructions for the intervention. There were four (4) major interventional activities which the students were taken through to grasp the concept of circles in geometry. The instructions for the activities were as follows:

1. The first activity introduced the students to circles. They were guided to identify circles, circumference, diameter, radius and centre of a circle, using real life situations. They were also guided through various practical activities to give explanations and meanings to the various components discussed. For example, one student stood in the middle of an open space, holding one end of a known length of a rope. Another student pulled the other end of the rope and walked round, placing colleague students evenly on the positions as he pulled and walked with the rope until he got close to the position of the first person. It was then explained that, the students' positions represent a fairly good circle, the length of the rope as the radius, and the student in the middle as the centre of the circle. The distance around the positions of the students was explained as the circumference (perimeter) and the surface inside the circle formed is the area and so on.
2. Activity two looked at how to measure circumference and diameter of circular objects. The students were taken through a systematic procedure of activities to find the circumference and the diameter of different sizes of cylindrical objects. Students were asked to check the measures of the radius and the diameter to identify that the diameter is approximately two times the length of the radius. For example, students were grouped and were asked to turn pieces of canes and raffia to form a circle. They were then asked to open them and by using the tape measure, find the lengths of the pieces of canes and the raffias to obtain the circumference. They were again guided to wind a string around the cylinders, taken the interval and open the string and measure the length on the tape measure or by using a ruler to obtain the circumferences of the respective circles and record them down.
3. Activity three took students through measures to find the relationship between the circumference of a circle and its diameter (deriving pi (π)). The researcher guided the students through various activities to find the circumference of various circles and their corresponding diameter. They were again guided to identify that; the circumference of any circle is always about three times its diameter. Therefore, the activities confirmed the value of Pi (π) in the relationship below

   $$\frac{c}{d} = \pi$$ or $C = \pi d$.
4. In activity four, the students were guided through step by step procedures to discover a formular for the area of a circle. The activities gradually prepared the students to understand that, if you have a given circle of radius 'r', it is possible to partition the circle into sectors. Each sector is approximately triangle in shape and can be rearranged to form an approximately parallelogram. The height of this parallelogram is 'r' and the width is half the circumference of the circle, (πr). Thus the total area is r x πr = πr^2.

4. RESULTS AND DATA ANALYSIS

Students were first given a set of questions to solve as the pre – test and they were then taken through a series of intervention activities after which they were given a post – test. The items were related to real world activities, application of knowledge and knowledge and understanding, as seen in Appendix A. The pre–test and post-test consisted of six (6) questions which were marked out of twenty-five (25) and was conducted for fifty (50) students each in SM 1 and SM 2. The results of the study obtained by the students were analyzed and discussed in relation to the research questions of this research. The first part dealt with the Descriptive analysis and the second part also looked at the inferential analysis of the data. Statistical Package for Social Scientist (SPSS) version 20 was used for the inferential analysis of the study. Tables 1 and 2 shows the frequencies and percentages of the respective scores for the SM 1 and SM 2 in both pre-test and post-test.

A careful observation of Table 1 and 2 indicated that the students' performance was abysmal in the pre-test which shows clearly that they lack the understanding of the basic concept of circles under geometry and therefore they were not able to use appropriate strategies and principles in finding solution to the mathematical problems. However, after the intervention activities, the post- test scores from Table 1 and 2 showed a tremendous improvement in the performance of the students in relation to solving of the questions administered to them and this was evidence of the good use of the problem-based approach of teaching and learning through numerous activities that they were taken through.

The researchers undertook inferential analysis of the pre–test and post–test, and the data used for this analysis were the scores obtained by the students in both tests. Tables 3 and 4 indicated the mean and standard deviation of the paired samples. The results from Table 5 and 6 of the P-value 0.000 shows statistically significant gain that indicated significant increase in scores on the post-tests as compared to the pre-test. For the study to be significant the P value should be less than 0.05.

The results therefore indicated that there is a significant difference between the pre–test scores and that of the post–test which is in favor of the post–test. And this was attributed to the intervention processes the researchers took the students through.

Table 1. Comparing pre-test scores and post-test scores for SM 1 class

Groups	Marks	Pre-test Frequency of Students	Post-test Frequency of Students	Pre-test Percentage of Students	Post-test Percentage of Students
Very low	1-5	12	0	24.00%	0.00%
Low	6-10	25	0	50.00%	0.00%
Medium	11-15	10	2	20.00%	4.00%
High	16-20	3	25	6.00%	50.00%
Very high	21-25	0	23	0.00%	46.00%
Total		50	50	100%	100%

Table 2. Comparing pre-test scores and post-test scores for SM 2 class

Groups	Marks	Pre-test Frequency of Students	Post-test Frequency of Students	Pre-test percentage of Students	Post-test percentage of Students
Very low	1-5	12	0	24.00%	0.00%
Low	6-10	24	0	48.00%	0.00%
Medium	11-15	11	3	22.00%	6.00%
High	16-20	3	25	6.00%	50.00%
Very high	21-25	0	22	0.00%	44.00%
Total		**50**	**50**	**100%**	**100%**

After the pre-test, intervention (using PBL approach of teaching) and the post-test to measure the students' achievement with regards to the topic circles under geometry, a quiz was conducted six (6) weeks after the post-test. The quiz was conducted after several different topics had been treated with the students. The idea for the time lapse was to find out the retention of the students understanding of concepts in the teaching and learning of circles. The post-test items were used for the quiz in order to ensure consistency in the tests. Tables 7 and 8 shows the frequencies and percentages of the respective scores for the SM 1 and SM 2 in both post-test and quiz after six (6) weeks.

After six (6) weeks of the post-test, the post- test and quiz scores from Table 7 and 8 showed no major change in the performance of the students in relation to solving of the questions administered to them. This indicated that the retention of mathematical concept among level 100 students in circles (geometry) has been improved through the use of problem-based approach of teaching and learning. Table 9 and 10 indicated the mean and standard deviation of the paired samples (Post-test and Quiz). The results from Table 11 and 12 of the P-value greater than 0.000 shows statistically insignificant gain that indicated insignificant increase in scores on the post-tests as compared to the quiz.

The results therefore indicated that there is no appreciable (significant) difference between the post–test results and that of the quiz which indicated that there is a strong retention of mathematical concept among students in circles (geometry). Again, this can be attributed to the intervention processes the researchers took the students through.

Table 3. Comparing means and standard deviation of pre-test and post-test scores of SM 1 class

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	7.4000	50	2.83627	.89691
	Posttest	21.4000	50	2.36643	.74833

Table 4. Comparing means and standard deviation of Pre-test and Post-test scores of SM 2 Class

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	7.6000	50	3.53396	1.11754
	Posttest	20.1000	50	2.84605	.90000

Table 5: Paired T-Test analyses of means of SM 1

	Mean	Std Deviation	T	Df	Sig (2-tailed)
Pre-Test& Post Test	-14.0	2.8	-15.7	49	0.0000

Table 6: Paired T-Test analyses of means of SM 2

	Mean	Std Deviation	T	Df	Sig (2-tailed)
Pre-Test& Post Test	-12.5	3.2	-12.5	49	0.0000

Table 7. Comparing post-test scores and quiz scores for SM 1 class

Groups	Marks	Post-test Frequency of Students	Quiz Frequency of Students	Pre-test percentage of Students	Quiz Percentage of Students
Very low	1-5	0	0	0.00%	0.00%
Low	6-10	0	0	0.00%	0.00%
Medium	11-15	2	1	4.00%	2.00%
High	16-20	25	26	50.00%	52.00%
Very high	21-25	23	23	46.00%	46.00%
Total		50	50	100%	100%

Table 8. Comparing post-test scores and quiz scores for SM 2 class

Groups	Marks	Post-test Frequency of Students	Quiz Frequency of Students	Pos-test Percentage of Students	Quiz Percentage of Students
Very low	1-5	0	0	0.00%	0.00%

Low	6-10	0	0	0.00%	0.00%
Medium	11-15	3	1	6.00%	2.00%
High	16-20	25	26	50.00%	52.00%
Very high	21-25	22	23	44.00%	46.00%
Total		50	50	100%	100%

Table 9. Comparing means and standard deviation of post-test and quiz of SM 1 class

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Posttest	21.4000	50	2.36643	.74833
	Quiz	21.9000	50	1.91195	.60461

Table 10. Comparing means and standard deviation of post-test and quiz of SM 2 class

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Postest	20.1000	50	2.84605	.90000
	Quiz	20.3000	50	2.58414	.81718

Table 11: Paired T-Test analyses of means of SM 1 Quiz and Post-test

	Mean	Std Deviation	T	Df	Sig (2-tailed)
Quiz & Post Test	-0.5	0.85	-1.9	49	0.096

Table 12: Paired T-Test analyses of means of SM 2 Quiz and Post-test

	Mean	Std Deviation	T	Df	Sig (2-tailed)
Quiz & Post Test	-0.2	0.63	-1.0	49	0.343

5. DISCUSSION OF RESULTS AND FINDINGS

Analysing the results in Table 1 and 2 above, it indicated the impact of the intervention by comparing the pre-test scores of the individual students with their respective post test scores. It revealed a significant improvement in students' performance after the introduction of the problem base learning approach by the authors. The post-test mean scores of 21.40 (Standard deviation of 2.37) and 20.10 (Standard deviation of 2.85) is significantly higher than the pre-test mean scores of 7.40 (Standard deviation of 2.84) and 7.60 (Standard deviation of 3.53). This indicated that the use of problem base-learning approach in teaching and learning of circles under geometry has brought about a tremendous improvement in students' performance. This revelation is in tandem with studies by Hung (2013), Cerker and Ozdamli, [23] and Wadami [24] which revealed that problem-base learning approach improve learners' performance by promoting their abilities and skills in applying knowledge, solving problems, practicing higher order thinking, and self-directing and reflecting on their own learning for conceptual understanding.

However, after six weeks of the intervention a quiz was conducted to measure the long-term impact of the intervention in comparison with the post-test results of students. The quiz mean scores of 21.90 (Standard deviation of 1.91) and 20.30 (Standard deviation of 2.58) is not significantly higher than the post-test mean scores of 21.40 (Standard deviation of 2.37) and 20.10 (Standard deviation of 2.85). There was no appreciable (significant) difference in students' performance after six weeks of the intervention by the authors. This indicated that the use of problem-based learning approach in teaching and learning of circles under geometry has improve the retention level of students thereby improving students' conceptual understanding. This suggests that, students were able to use their own experience to create their own understanding from the intervention. This observation is not new as a study by Arthur, Asiedu-Addo and Assuah, [17] admitted that adopting modern pedagogical strategies that can stimulate the students to learn can enhance conceptual understanding and thereby promoting retention of concept understanding. Through that they were able to gain the right competencies and approaches in solving the questions. With this, they also acquired the basic requisite geometry concepts in their understanding of the problems and it also paved the way for the average students to help their low performing classmates through cooperation. This is in line with Andam *et al.* [16] which suggests that in every classroom, students are expected to learn mathematics concepts while acquiring processed skills, positive attitudes and values and problem solving skills.

In summary, the findings of the study clearly showed that, the problem-based learning (PBL) has improved the mathematical problem solving abilities of the students in circles. It has also improved the students' retention of knowledge with respect to the concept of circle under geometry. Again, the research work has confirmed the theories (Constructivist theory, Piaget's theory and Bruner's theory) that, learning is more lasting, if students are guided by teachers to construct their own knowledge by linking new information to prior knowledge and blending with the experiences (home and the environment) of the students [28].

6. CONCLUSION AND RECOMMENDATIONS

Mathematics has been an intimidating subject for many people, particularly in the area of geometry. There was the need to adopt teaching and learning strategy that can help addressed learners' short comings. The main intervention for this study was problem-based approach of teaching and learning. The statistical analysis showed that the intervention activities by the researchers helped improve students' competencies in solving problems in circles under geometry. The intervention which was moved from recall of basic facts, to more of thinking, doing, linking activities to the home and creativity of the student also led to the students developing a more positive attitude towards mathematics and retention of concept in general.

The study recommended that;

- ✓ Teachers must engage students in relevant practical activities during teaching and learning of mathematics to allow the students to find out things themselves.
- ✓ Teachers are to remain focus and design teaching and learning activities to encourage the learner to make links between external world and internal thought.
- ✓ Activities designed by teachers should be well linked to home/real life and the curriculum.
- ✓ The activities must be challenging. It should be appealing to the students in the class in order to involve each and everyone. This involves the selection of appropriate local materials that suit the purpose of the lesson to arouse learners' interest.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX A

Pre-Test Items

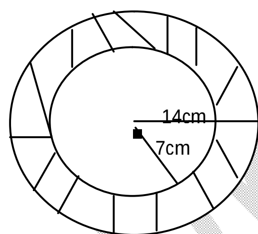
Answer All Questions. Time: 1 hour

1. A cylindrical food can has radius 9cm.

   (a) Find the length of the label which will just go round the can (π = 3.14).
   (b) Give reason (s) to support your answer.
   (c) What is the diameter of the cylindrical food can leaving your answer in millimetres

2. Two circles of radii 6cm and 10cm have the same total area as the third circle. What is the radius of the third circle (Take π = 3.142)

   b. Find the area of the shaded region below:



(π = 3.14)

3. A goat has a 4m rope attached to it collar, and the rope is tied to a stake in the middle of a lawn.(i) What is area of the grass the goat can graze?

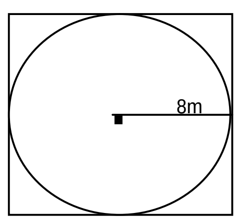
   (ii) How far will the goat travel, if it walks around the lawn at the limit of its leash?

   (Take π = 3.142)

4. The circumference of a circle is 28πcm. Find the area of the circle. Given that π = 3.142
5. Below is a square plot of land with a circular fish pond inside the plot touching the sides of the plot. A peg at the centre of the pond has a rope tied to it stretched to a side of the pond. If the length of the rope from the peg to a side of the pond is 8m,

(a)What will be the perimeter of the pond?

(b) How much area of the plot was not covered by the pond?



($\pi = \frac{22}{7}$)

6. If the area of a circle is $160cm^2$, find the circumference of the circle leaving your answer in two decimal places. $\pi\frac{22}{7}$

APPENDIX B

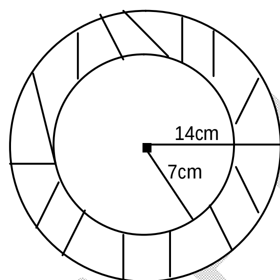
Post-test Items

Answer All Questions. Time: 1 hour

1. A cylindrical food can has radius 9cm.

   (a) Find the length of the label which will just go round the can (π = 3.14).
   (b) Give reason (s) to support your answer.
   (c) What is the diameter of the cylindrical food can leaving your answer in millimetres

2. Find the area of the shaded region below:



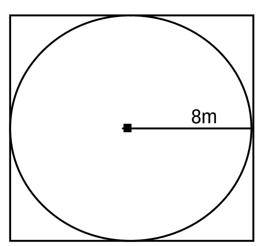
(π = 3.14)

3. Two circles of radii 6cm and 10cm have the same total area as the third circle. What is the radius of the third circle (Take π = 3.142)

4. The circumference of a circle is 28πcm. Find the area of the circle. Given that π = 3.142.

5. Below is a square plot of land with a circular fish pond inside the plot touching the sides of the plot. A peg at the centre of the pond has a rope tied to it stretched to a side of the pond. If the length of the rope from the peg to a side of the pond is 8m,

   (a) What will be the perimeter of the pond?
   (b) How much area of the plot was not covered by the pond?



($\pi = \frac{22}{7}$)

6. A goat has a 4m rope attached to it collar, and the rope is tied to a stake in the middle of a lawn.

(i) What is area of the grass the goat can graze?

(ii) How far will the goat travel, if it walks around the lawn at the limit of its leash?

(Take $\pi = 3.142$)