

Effectiveness of Constructivist approach in teaching concepts of Geometry

¹Sheena Thomas, ²Dr K B Subramaniam & ³Dr Fr Joseph PP

¹HoD & Assistant Professor, Dept of Education, The Bhopal School of Social Sciences, Bhopal (India)

²Retd Principal RIE, Bhopal (India)

³Manager, St Xavier's School Bhopal (India)

ARTICLE DETAILS

Article History

Published Online: 10 January 2019

Keywords

constructivist approach, Tangents

*Corresponding Author

Email: sheenathomas04[at]gmail.com

ABSTRACT

This paper is the outcome of an experimental study wherein the researcher conducted a study on the students of VII standard and taught them the concept of Tangents. Students participated fearlessly in the teaching learning process. The results indicated that the constructivist approach worked well with students and they participated actively in the whole process constructing meaning for themselves and taking the ownership of learning.

1. Introduction

Lev Vygotsky is credited with the idea of Constructivism^[1], the pedagogy which believes in learning through knowledge construction, and not simply transfer of transmission by the teacher to the learner.

Constructivism with all its promises has been in hot waters over its utility in all subjects^[2] especially a subject like Mathematics^[3] where the content is purely abstract in nature. This was a concern of the second and the third author which encouraged them to discuss the utility of constructivism in mathematics with their colleagues, a group exclusively of teachers from all school subjects. Most of the teachers agreed that constructivism is indeed as useful as promised in teaching-learning, but very difficult to implement in everyday classroom.

Literature review in India and abroad showed that constructivism is a highly successful pedagogical approach to teach sciences and even languages but very little evidences was found to show that it was equally successful for teaching mathematics especially implementing in classrooms.

It seems as though a belief in a constructivist approach to knowledge or learning is contrary to the fields of mathematics, where knowledge is viewed as true facts, principles, theorems, and laws. In literature, however, it makes sense that the reader constructs her own meaning of the works of William Shakespeare or Maya Angelou because she is interpreting the writings and intentions of the authors. But there is only one interpretation of two plus two equals four. There is a danger in trying to apply the logic of individual interpretation with mathematics because constructivism is not questioning the interpretation of simple arithmetic or the notion of gravity; rather it is saying that each person comes to arrive at their own conclusions and conceptions.

After going through many resources and reviews on constructivism in mathematics the second and the third author were not satisfied as they could not find classroom situations

designed constructivistically. There was a lack of evidence with regards to practical implementation of constructivism in classrooms. With this problem in mind the second and third author approached the first author and explained to him their concern.

The following conversation ensued:

2A & 3A: *Do you think constructivism is an over rated approach.*

1A: *Not at all*

2A & 3A: *But it was originally used for teaching sciences particularly biological sciences because the content in that case is concrete. How to convince teachers?*

1A: *I agree to what you say but Mathematics is meant to be taught using constructivism. In fact it is the best tool to teach Mathematics.*

We would like to see a demonstration of it.

1 A: *I accept. Arrange a class on any day and I will demonstrate it to you both.*

2 A: *Which class and which topic (Indian school system is of the pattern 10+2+3 in accordance with Kothari commission; an Indian policy document)*

1 A: *any class and any topic*

2A: *But sir will you not make a lesson plan?*

1A: *One must never make a lesson plan when one teaches using constructivist pedagogy.*

But Sir, at least tell us what topic would you teach?

1A: *I can't reveal that to you at this moment*

3A: *But Sir, we have to arrange the class according to the topic.*

1A: *It's ok; arrange whichever class you want I will teach them the topic I have thought of.*

2A & 3A: *ok sir we will definitely make necessary arrangements.*

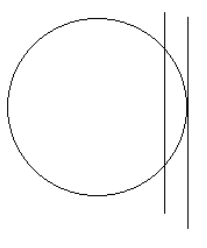
St Raphael is a reputed school in the sub-urban area of Bhopal. The children come from various socio-economic backgrounds, and are housed under one roof, in the care of scholarly teachers. For the purpose, we were lent one class of Std VII. The students very informed that a new teacher would come to talk to them about mathematics.

One the said day, the learners were asked to assemble in the classroom at a fixed time. The researcher, after the initial introductions asked the children to close their notebooks. Most of the children seemed surprised by this, as a common perception of children regarding mathematics is that one needs to note everything, in order to learn it. This was, as they later told the researcher, never told to them during a mathematics class. In fact, they were told to write, and re-write to learn mathematics. The first author also asked the students to answer individually by raising their hand, and not altogether.

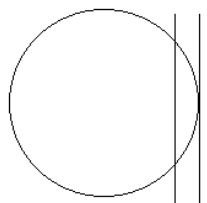
Then, the researcher asked at random of the children to draw a circle on the chalkboard. She made an irregular one, though to the best of her abilities. The researcher then noted that some of the children were unsatisfied with the circle on the board. The researcher then playfully challenged the others to draw a better circle. One of the children volunteered, while the others watched with curiosity. Then, when the second child summed up his drawing, the children were asked to draw another one. A third child raised her hand in answer to it, and made a circle on the chalkboard. The researcher then asked the children, "which one out of these is the best circle?" the children answered unanimously, "the Third One!"

(This exercise was performed to make the students comfortable)

Now the researcher sketched three straight lines on the board and asked the students to identify the difference between the lines drawn.



Supriya: all three are of different lengths.
 Researcher: (rubs on the chalkboard to make the lines equal in length) Now, what is the difference between them.



Aditya: (pointing to the outermost line) this is far from the circle.
 Priya: (pointing to the innermost) this line is cutting the circle.

They students seemed doubtful about the line in the centre. They simply said that it was in the middle of the two. Then to help them visualize better, the researcher stood outside the boundary of the classroom, and asked the students, "Where am I?"

All the Children : outside the class.
 Researcher : (walking into the class) Now where am I?

Children enthusiastically answered, "Inside the Class."

The researcher then stood on the exactly on doorway of the classroom and asked the students, now tell me where am I?

Mohit: Sir, you are neither inside nor outside.
 Researcher: where is that exactly?
 Mohit: in-between.

Meena: you are just touching the class, but you are neither inside nor outside.

Researcher: ok. Now look at the circle again. What is the middle line doing to the circle?

Meena: it is touching the circle.
 Researcher: give it a name.
 Prabhu: Lets call it 'Touch Line'.

Researcher : does everybody agree to this name?
 All the children: Yes sir! (at that juncture the term "tangent" wasn't important, one must avoid jargons as much as possible) (Thus the concept of tangents was established)

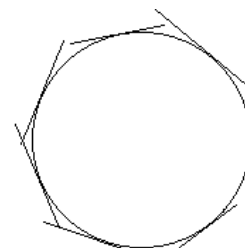
Next, the researcher asked the learners, "Now tell me, how many touch line can be drawn to a circle, come and draw them one the board."

Pritee came to the Black board and drew three touch lines. Some of the children started objecting and pointing on to the board.

Researcher : what is the matter?
 Madhu : there can be more touch line, not just three?
 "Then draw them on the board."
 Umm...I can't.
 Why?
 There are so many!
 How Many?
 Many (Gesturing though hand)!
 Still, how many?
 As many as you want.

Ok! Do all of you think that there are as many touch line as we want?(many teachers, give the word infinity which should be avoided)

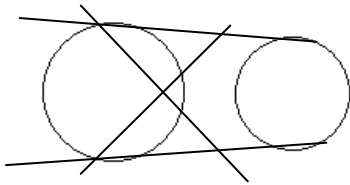
All : YES!



All right. Then it is established. Now tell me, how many touch line can be drawn when there are two circles, like this (draws on the board).



The students volunteered one by one till four touch line were drawn as shown below.

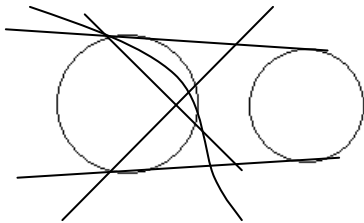


Researcher : Can any more touch-lines be drawn?

Most of the students are quiet at this moment, when Aditya raises his hand.

Researcher : yes Aditya, can you draw anymore touch lines in this figure?

Aditya : one more can be drawn.
(coming to the board)



Other children in the class start giggling and some even laugh.

Researcher :what is wrong?

Manish : Sir, Aditya is wrong. That is not a touch line.

Researcher :why?

Manisha : Because that isn't even a line. So it can't be a Touch line.

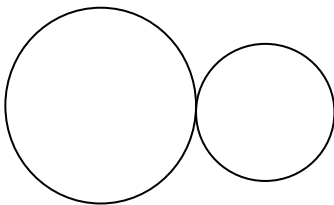
Researcher : do you agree, Aditya?

Aditya : That's right sir, I did not think it that way.

R :ok. So how many touch lines can be drawn in this case?

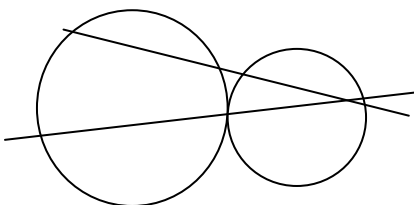
All :four.

R :all right. Now tell me, how may touch lines can be drawn in this case?



Praveen : sir can I try?

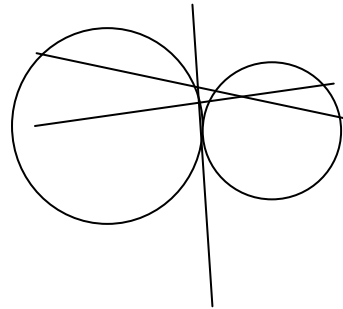
R :Sure. Here's the chalk.
(Praveen drew the following)



R :that's great. Can any more be drawn?

Riya :yes sir. I can draw one more.

R :of course. Do it.



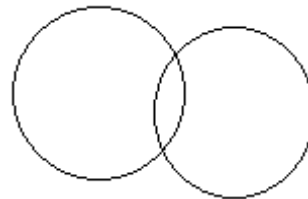
Researcher :Can any more common Touch-lines be drawn for these two circles?

All :no sir!

Researcher :so what can you conclude?

Pritee: Two circles can have either four or three common touch lines.

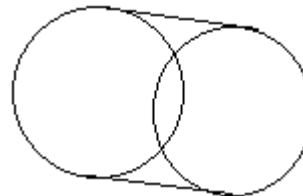
Researcher :That's right! Now, think; how many common touch lines are possible between these two circles?



Manish :Sir, there can be two touch line drawn here.

Researcher :Alright. Show us on the board.

Manish (Draws on the board)



Researcher: Very good Manish. Now, are there any other common touch-lines possible among these circles?

All :(after some deliberation) no sir!

Researcher :Are you sure?

All :Yes sir!

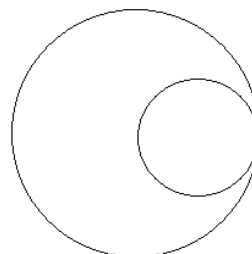
Researcher :Can you bet on it?

All :(after discussing among them) Yes sir, we can bet that there are no more common touch lines possible in this case.

Researcher :It is settled then. There are only two touch lines possible in this case. So what can you conclude about common touch lines now?

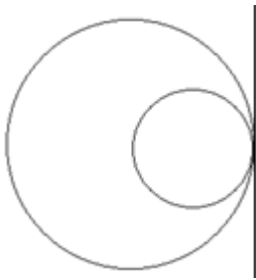
Ravi :There can be two, three or four common touch lines in two circles.

Researcher :lets see another case then. (Draws on the board)



How many common touch lines are possible now?

Ravi :sir, I think there is only one touch line which is common to both the circles here. Let me draw it.



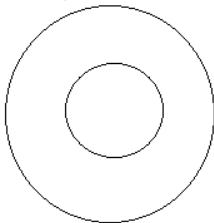
Researcher :That was very quick! You are absolutely right for this touch-line. But are you sure no other touch lines are possible?

Lovely :However much I think, I can't see any other line common to both, and touch in just one point. I agree with Ravi in saying that there is only one common touch line in this case.

Researcher :so what can you conclude?

Lovely :Two circles can have one, two, three or four common touch lines.

Researcher :correct. But, I have another case in front of you, which you will find very interesting. (Draws on the BB)



By this time the children were jubilant and very pleased with themselves. The researcher reminded them that they must not answer in group, but singly. The children were more than eager to blurt out the response, as they figured it very quickly.

Reena : sir, there are no common touch lines to these two circles.

Researcher :Then what change can we make to our earlier conclusion?

Reena :Two circles can have either zero, one, two, three, or four common touch lines among them.

Researcher :that was very well said. By the way, can you think of a situation when two circles may have more than four common touch lines?

Kevin: Do you mean five?

Researcher: I didn't say so. It can be anything.

Ravi :(sceptically) that's not possible!

R :Are you sure?

Ravi :I am positive.

Researcher :But I can bet with you that there is such a possibility where two circles can have more than four common touch lines.

Ravi :Let me think about it.

R :Can any of you think of a situation like that?

Teachers were perplexed so were the second and third authors.

There was a heavy silence in the classroom. All the students, from the first row to the last, were intrigued. Some were busy trying out circles on paper, some were discussing in low voices, and some were staring into the space, no doubt visualising circles which had common touch lines, for their little inquisitive fingers moved about in air as they did so. Circles were made and rubbed off. Some even took out their water bottle covers to make accurate circles, hoping for some sudden insight. Suddenly, in that quiet, brooding classroom, a jingle of bangles drew everyone's attention. A little girl on the last bench had raised a bangle-d hand, signalling that she knew the answer. The whole class laughed at her. The children seemed surprised, for the researcher later came to know that she was the quiet one of the class. She was called in front of the classroom. When given a chalk to draw on the board, she refused, saying that she can show it. Then, she took out her bangles, one from each hand, and superimposed one on top of the other. And then she said, "Now you may draw as many touch lines as you want."

The whole class broke into applause and the shy little girl, Chandra, bowed and ran back to the refuge of her seat. And then she was asked to state what she did.

Chandra said, "For two circles with the same radius which are placed one over the other, there can be as many common touch lines as you want."

Now the class was jubilant and felling happy as they knew now, the joy of learning. The researcher informed them that the topic they learnt was formally called 'Tangents', and wouldn't come in their syllabus until X Grade. That left the children very surprised, and obviously pleased with themselves. The class was reaching its conclusion, and the researcher announced that it would be all for that day. The students immediately started pleading , asking him to continue some more. The researcher then gave them as riddle

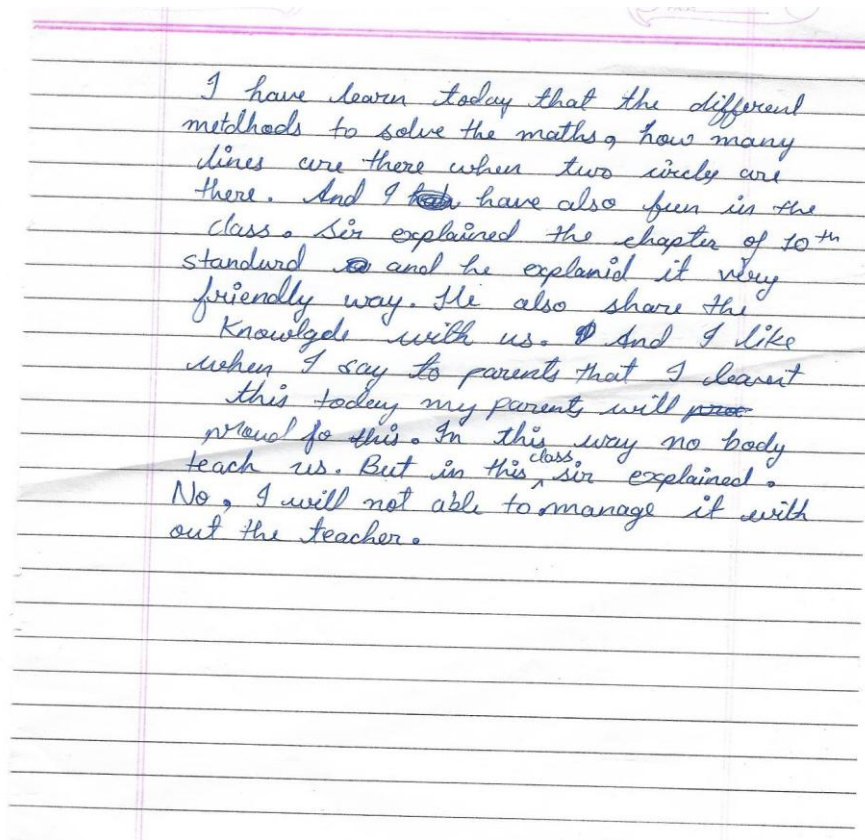
Using four 4s and the operations of addition, subtraction, multiplication, and addition make up as many natural numbers as you can.

The students immediately put their heads together for this challenge, while the researcher watched over and strolled through the class, occasionally stopping to see their efforts. The students where actively writing down the numbers and every time one of the children would come up with a solution, they'd go write it on the chalk board. Soon, the students realised that there is more than one way of getting a number, and it instilled the confidence of trying out new methods to get a particular number. Some even tried other combinations, like using five 5s, etc. If some of the students were not able to get a number, the researcher would advise them to move on to the next number, which lessened the peer pressure on them, as they would find out the next solution, and got a sense of achievement, and confidence to come back to the previous problem. It was observed that this method of teaching created a very dynamic and pleasant environment, which was rich in creativity, and devoid of unhealthy competition. As the time assigned to the researcher was almost up, he bade goodbye to the students, and this time, though they were hoping he would

come back, they were very eager to solve the problem on their own.

them, and they were requested to pen it down. The results have been tabulated and some of the randomly chosen responses have been attached below.

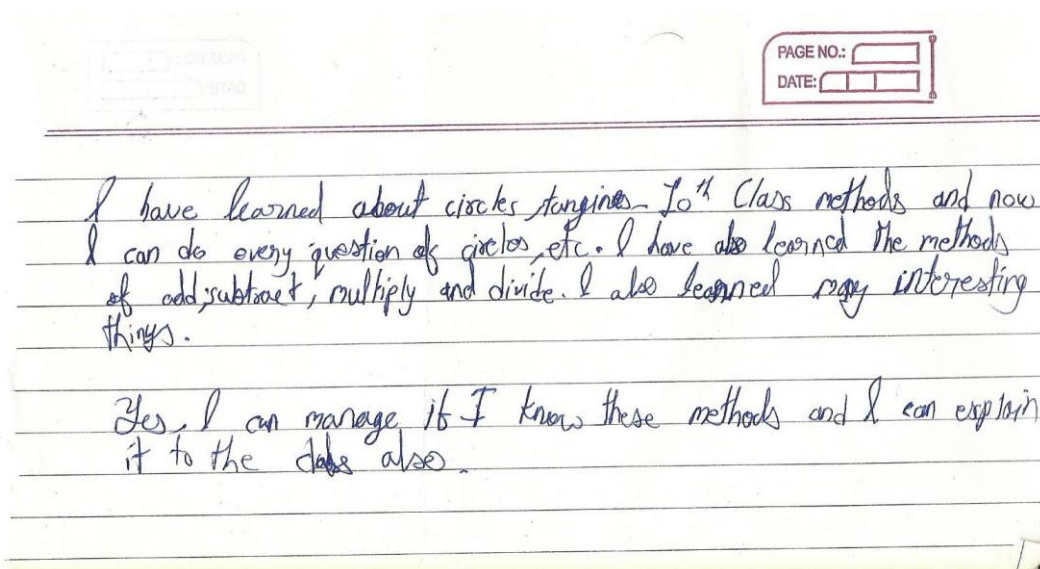
After the session ended, the students were rounded up for feedback. A set of previously framed questions was asked to



I have learned today the different methods to solve Maths today, how many lines are there when two circles are there. And i also had fun in the class. Sir explained the chapter of X standard and he explained in a very friendly way. He also share his knowledge with us. And I would like to say to my parents what I learnt in class today and my parents will be proud of this. In this way nobody has taught us. But in this class Sir explained.

No, I will not be able to manage the class without the teacher.

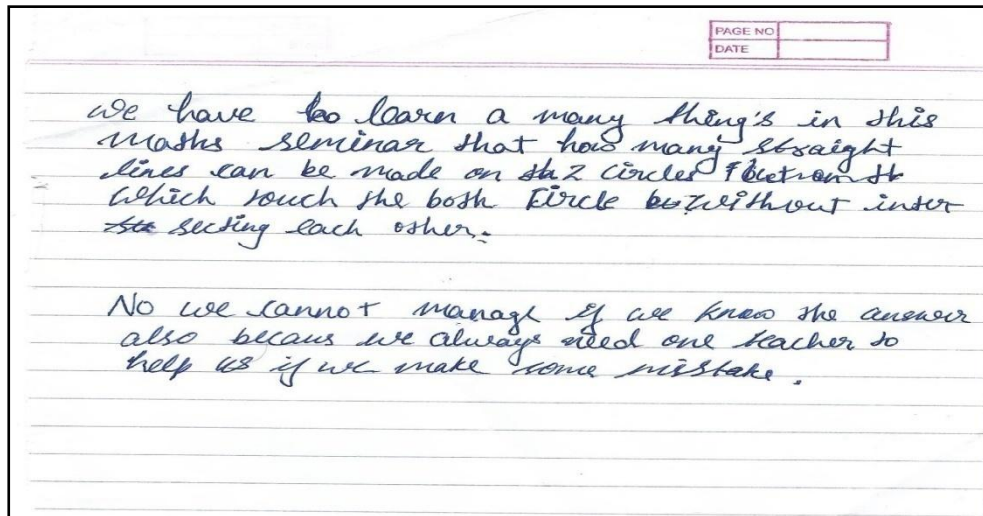
The student has highlighted fun way of learning and friendly approach in learning. Both the above said approaches are important parameters of constructivist approach. Student here is tuned to Indian education system, so he is not able to imagine a class without teacher's presence.



I have learnt about circles, tangents X class methods and now I can do every question of circles etc. I have also learned the methods of add, subtract, multiply and divide. I also learned many interesting things.

Yes I can manage if I know these methods and I can explain it to the class also

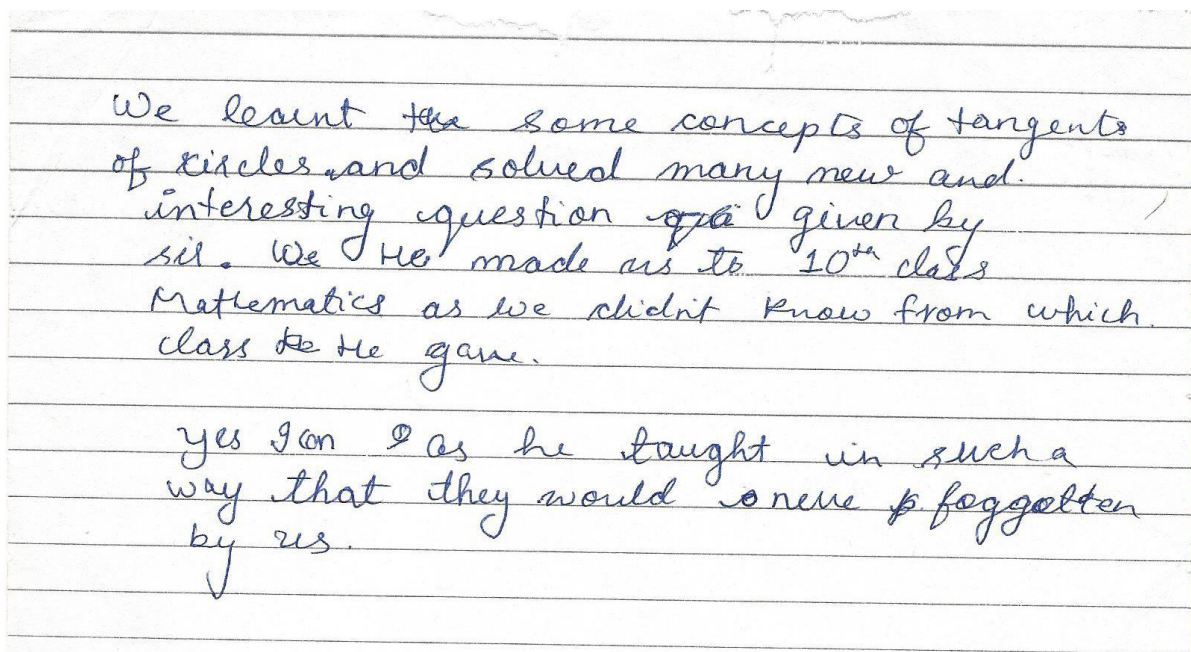
Student is confident that he will be able to manage the class without the teacher. The learning in the process was so concrete that the student feels that he will be able to take the class without the teacher around.



The student here changes his views regarding the teacher. From the earlier opinion of a teacher being an instructor to a teacher being a facilitator. The presence of a teacher is required because she can scaffold the learning and the students will not deviate too far from the goal

We have learnt many things in this maths seminar that how many straight lines can be made on two circles which touch both the circles without intersecting each other

No we cannot manage even if we know the answer also because we always need one teacher to help us if we make some mistakes.



We learnt some concepts of tangents of circles and solved many new and interesting questions given by sir. He made us to do class X Maths as we didn't know from which class he gave.

Yes I can as he taught in such a way that they would never be forgotten by us.

The student talks of interesting participatory kind of learning which will pave way for better retention

References

1. Marlene Schommer-Aikins, Orpha K. Duell, Rosetta Hutter (2005) ,Wichita State University, Mathematical Problem-Solving Beliefs, and Academic Performance of middle School Students examined the structure of middle school students'
2. Bolaji (2005), influence of students' attitude towards mathematics
3. Perry B et al (2002) studied the association of beliefs towards mathematics and the teaching-learning scenario of the subject
4. Cao, Zh. and Bishop, A. (2001) Students' attributions of success and failure in mathematics: findings in China and Australia.
5. Xin Ma, University of North Brunswick and Nand Kishore (1997), University of North Columbia in their dissertation conducted a meta analysis on correlation of mathematics to student attitude towards the subject.
6. Gadgil (1979), causes of failures at the SSC examination
7. Saha (2007) ,'Gender, Attitude to Mathematics, Cognitive style and Achievement in Mathematics'
8. Hariharan D (1992) 'Attitudes of high school students towards homework and achievement in mathematics'
9. Rosaly A (1992), relationship between attitude of students towards mathematics
10. Reynolds (2001) while reviewing research into teacher effectiveness concluded that two factors mostly affect learners' performance: the opportunity to learn; and time on-task (Reynolds et al., 2001, as cited in Pedagogy and Practice 2004; Crown Copyright, Unit 20, p. 21
11. Solangi et al (2008); Alyas, 2010; Hussain et al. 2011 "calls for constructivist mathematics educators to develop a new 'mathematico- anthropological context' in order to refine and apply their ideas to mathematics classroom environments" (Boudourides, 1998).
12. Paul F.Conway, University College, Cork (UCC) Finbarr C. Sloane(2005) October, International Trends in Post-Primary Mathematics Education
13. Arizona State University ,AZ, USA, National Science Foundation (NSF),Washington, DC, USA, The dramatic advances in technology will almost surely force change both in what mathematics is taught and in how it is taught.
14. Krishnaveni, A.R. A. (2014), studied "An Essential Elements of Developing Soft Skills in Learning Mathematics"
15. Maria de lourdo mata,Vero Monteiro, Francisco Peixoto (2012) did a study on "Attitudes towards Mathematics: Effects of Individual, Motivational, and Social Support Factors" on 1719 Portuguese of fifth to twelfth grade students.
16. Choudhary. E. (2002-03), had done a study on "A Study of Classroom Environment, Achievement Motivation and Attitude towards Mathematics".
17. Mohamed, L. & Waheed, H. (2011) conducted a study on "Secondary Students Attitude towards Mathematics in a Selected School of Maldives
18. Leticia, E. & Garduno, H. (2015) had conducted a study on "The Influence of Cooperative Problem Solving on Gender Differences in Achievement, Self- Efficacy, and Attitude towards Mathematics Gifted Students"
19. Cecil D. Mercer (University of Florida) LuAnn Jordan (University of Florida) Susan P. Miller (University of Nevada, Las Vegas) Implications of Constructivism for Teaching Math to Students with Moderate to Mild Disabilities.
20. Steve Graham (University of Maryland) Karen R. Harris (University of Maryland) Implications of Constructivism for Teaching Writing to Students with Special Needs
21. Shu Ching Yang (National Sun Yat-Sen University) Dr. Shu Ching, Yang Professor Graduate Institute of Education, National Sun Yat-Sen University, Synergy of Constructivism and Hypermedia from Three Constructivist Perspectives— Social, Semiotic, and Cognitive. I
22. Boitumelo Mangope Department of Educational Foundations University of Botswana Private Bag- 00702, Gaborone Botswana- 00267 E-mail: majorte@mopipi.ub.bw the Constructivist Theory in Mathematics
23. Woodward and Baxter (1997), A study of an innovative approach to maths
24. Card (1998), examined the levels of achievement and metacognition in expressing mathematics ematics
25. Patrick W. Thompson, The Constructivist Teaching Experiment in Mathematics
26. Choudhury R (1999) 'Some problems in learning mathematics at secondary stage with relation to high schools in greater Guwahati'ch
27. Sharma A K (1978) PhD thesis ' A critical study of the achievement in mathematics by pupils of secondary schools with particular reference to the state of Assam'
28. Das R.C. and Barua A.P.(1968) in their work, "Effect of Remedial Teaching in Arithmetic, A Study with Grade IV Pupils, SIE, Assam"
29. Rastogi S. (1983) Ph.D thesis 'Diagnosis of Weaknesses in Arithmetic as Related to the Basic Arithmetic Skills and Their Remedial Measures'