



Transforming Mathematics Education With Technology

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Abstract

Necessity is indeed the mother of invention. The genesis of all mathematical development stems from practical needs. But soon it transcends the confines of its immediate utility. Mathematics has always played and will always keep playing an important role in our day – to – day life. Though the subject is very important it is always considered to be the most difficult and fearful. The dryness of the subject can be contributed to the teaching of the subject. It is also believed that mathematics is an exceptionally difficult subject, i.e., its study requires special abilities and intelligence; therefore everybody should not be enough to learn it successfully. References are made to low pass percentage in this subject in examinations. The teaching of mathematics presents numerous day-to-day problems for the teaching of mathematics. Due to inefficient and stereotyped methods of teaching, the subject is sometimes decried as dull and dry. In the pedagogical study of mathematics we mainly concern ourselves with two things; the manner in which the subject matter is arranged or the method the way in which it is presented to the pupils or the mode of presentation. The aims of Mathematics Education is not being satisfied by the traditional methods of teaching and learning. Thus there is a need of transforming mathematics education. A positive attitude can be developed if mathematics teaching - learning is made interesting, effective and child-centered with proper incorporation of technological advancements in imparting the knowledge of mathematics. Research has shown that the appropriate use of technology can transform the traditional mathematics classroom into a dynamic learning environment where the student is actively engaged in constructing mathematical concepts and knowledge.

"Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM 2000) implies the importance of technology in mathematics education. Technology enables users to explore topics in more

depth (e.g., interconnect mathematics topics, write programs, devise multiple proofs and solutions) and in more interactive ways (e.g., simulations, data collection with probes).

Technology in this regard, is one of the most critical issues in the present global era. In order to gain a clear perspective of one's own situation and to compete globally now there is a need to think globally and act locally. Technology in acquiring knowledge, skill and attitude is an extremely essential component of education and training at all levels of education. Technology is a vital tool for mathematics instruction in classrooms. Unfortunately, this tool is frequently underutilized by even the most skilled teachers due to the lack of experience in using instructional technology.

The present paper discusses the need of for transforming Mathematics Education with the help of technology, it describes the integration of technology in Mathematics Education and use of various tools of technology for teaching learning of mathematics. It describes the use of Geogebra as an effective tool to teach mathematics.

INTRODUCTION

Education is one of the most powerful systems of our society for the growth and development of a nation. Napoleon has aptly commented that "*the progress and the improvement of mathematics are linked to the prosperity of the state (nation)*". It has been very popularly said about mathematics, "It is a science of all sciences and art of all arts." It is pivot of all the sciences and arts. Modern nations see value in building a mathematically literate society and hope for a strong mathematical elite that Mathematics represents a high level of abstraction attained by the human mind can shape the knowledge economy of the 21st century.

In India mathematics has its roots in vedic literature which is nearly 4000 years old. India, with its strong mathematical traditions, may be expected by the world to produce excellence in mathematics. In a population that is largely poor, education is seen as the key instrument to break out of poverty. The national policy of education on 1986 saw mathematics as "Vehicle to train a child to think, analyze, reason and articulate logically". The ability to calculate, estimate and predict are essential life-skills that education must impart with mathematics education. But, what one perceives is a sense of disappointment that school education does not impart such skills and one stain has been persistent is the anxiety and failure associated with Mathematics. It is often referred as the 'killer' subject and studies showed that a large

number of children were failing or dropping out before completing elementary school because they could not cope with the demands of the mathematics education. The report 'Learning without Burden' (Government of India[GoI], 1993) had pointed out that children were in fact not 'dropping out' but were being 'pushed out', owing to the 'burden of non-comprehension', as a result of an irrelevant curriculum, distanced from the lives of the majority, and often rendered 'boring and uninteresting' by outdated teaching strategies.

The Right to Education (RTE) Act for children aged 6-14 years mandates "Learning through activities, discovery and exploration in a child centred and child friendly manner" by making the child free of fear, trauma and anxiety" (Section 29, GOI, 2009).

The main goal of mathematics education emphasized in NCF 2005 is 'mathematization of the child's thought and process'. The narrow aim of school mathematics is to develop 'useful capabilities, particularly those relating to numeracy - numbers, measurement, decimals and percentages'. The higher aim is to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes the way of doing things and the ability and the attitude to formulate and solve problems. It also urged focus on developing concepts and learners' own ways of solving problems and building new algorithms rather than remembering short cuts and efficient ways to calculate.

If the above mentioned goals needs to be achieved mathematics education needs to be transformed from the present scenario to a new beginning. The expectation is thus that mathematics emerges as a subject of exploration and creation rather than as an exercise of finding old answers to old and complicated problems. The last few decades have witnessed serious experimentation and research in mathematics education all over the world and there has been tremendous shift of paradigm as far as mathematics teaching is concerned. Mathematics Education has been revolutionized with the advent of new and powerful technological tools. Because of these technological tools mathematics education can focus on problem solving and reasoning that empower students to explore, conjecture and reason logically

Need to use technology for mathematics education

The use of technology in mathematics encourages teachers and students to engage in deep mathematical thinking involving analysis, problem solving and rich conceptual understanding. Gone are the days when students remained passive listeners and the teacher ruled the roost in the class. Today, the students, being more tech savvy, are far more enlightened and often a step ahead of their teachers. To keep pace with the changing scenario teachers need to upgrade themselves with the technological advancements. This would help them to motivate themselves, share ideas, discuss new problems, broaden their horizon and ignite the spark within.

With the evolving technological tools, it is also possible to link our mathematics discoveries to areas such as in sciences, technology and engineering. Invest in mathematics teaching and research in higher education is essential for cultivating student's innovation and creative thinking skills. While professional trainings in the area of content knowledge for secondary schools (middle or high schools) are important.

It is equally important that we promote exploratory activities which allow students to think and solve problems creatively in different levels of education. Technological tools can expand their mathematics knowledge and promote their creative thinking skills. Creativity does not come from drills. The education reform is a vital step for increasing the manpower strengthening the development of the country. Technological tools will play an important part for this integration; due to the pressure of examinations, teachers often utilize the designated mathematics experimental periods for doing more drilled or rote type math problems. This is a typical situation in many examination oriented countries.

If we look at some of those university entrance examination math problems, we realize that we are teaching students skills in memorization and special techniques of solving problems. As a result, we may have lost many potential students who cannot perform well in a test. Therefore, it is not difficult to conjecture that if the depth of a course in math is too deep, students may lose interests in studying mathematics early; on the other hand, using technological tools when exploring graphical representations in a math topic may inspire students' interests in learning more mathematics. In short, we need to allow students to explore problems that are not discussed in a regular textbook or at a traditional classroom.

With current technological tools, an applied mathematics problem or project can be explored from different perspectives. Therefore, educators and researchers from all disciplines should work cooperatively to design proper set of projects for students to explore in different levels, from middle school to university and beyond. Consequently, new concepts or knowledge learned from exploration can be acquired naturally when students move from one level to the other. Author believes that mathematics knowledge gained through exploration will stay with learners for life. On the other hand, knowledge gained from preparing for an examination may last only briefly. Everyone will agree that examination is one way but not the only way to measure student's understandings.

Technology becomes a bridge to make us rethink how to make mathematics an interesting and across disciplinary subject. Through the advancement of technological tools, learners will be able to discover more mathematics and its applications.

Integration of technology in Mathematics Education

In current technological era, students are exposed to solving problems with various software packages. Consequently, teachers and educators need to update themselves in seeking and designing proper sets of problems where mathematics knowledge can be integrated in interdisciplinary areas. A sound mathematics curricula should include component where exploration is cultivated and encouraged.

There is need for greater focus on developing relevant content and applications and using them to enhance learning across subjects, to ensure improvement in quality of education. There are no standards or guidelines available at a national level to develop or choose relevant content. Most content used in schools are developed by teachers themselves as a result there is no uniform content used. While content creation by the teachers and students themselves is a positive trend enabling ownership; one needs to weigh the pros and cons of not having a professional content development team who can involve teachers and faculty in the process. Off the shelf products which are available need have some scope for flexibility and customization to give a sense of ownership to users.

How to Integrate technology for mathematics education

Still the fact that the impact of Technology use to date on learning outcomes is negligible in most places, at least partially attributable to the fact that, in most places, computers are only used to teach 'ICT literacy'. It is hoped that initiatives like "Rashtriya Madhyamik Shiksha Abhiyan (RMSA)" and "National Mission for Education through ICT"[8] will make a difference in coming areas. It is however clear that we no longer have a choice. It is no longer an "if" but "how" to deploy the technologies optimally. A shift in the role of a teacher utilizing Technologies to that of a facilitator does not obviate the need for teachers to serve as leaders in the classroom; traditional teacher leadership skills and practices are still important (especially those related to lesson planning, preparation and follow-up).

Integration of Technology can help in achieving many of the above objectives of pedagogy.

1. **Lesson planning:** It is crucial when using Technologies. Research shows that where little planning has occurred, student work is often unfocused and can result in lower attainment.
2. **Relationship between technology, knowledge and content:** At present technology training appears to focus mainly on technology knowledge and skills while overlooking the relationships between technology, pedagogy, and content. As a result, teachers learn about "cool" stuff, but they still have difficulty applying it for their students' learning.
3. **Technology as a tool for enhancing teaching and learning:** Technology is often used simply as a supplement for existing pedagogical practices. However in order to fulfil the potential of Technology as a tool for enhancing teaching and learning, it must be fully integrated into pedagogical processes, which requires a cognitive shift on the part of educators, curriculum developers, administrators and policy-makers.
4. **Practice effective technology:** Teachers need opportunities to practice effective technology integration strategies in supportive contexts during technology courses, technology-integrated methods courses, and field experiences.
5. **Learn new technologies:** Experienced teachers also need opportunities to learn about new technologies and ways to integrate them effectively in their classroom.
6. **Teacher training course:** There is a strong need for teaching technology-tools to pre-service teachers.

For a rich variety of ICT resources on integrating them in teaching and learning, see

the following graphs. The first graph describes the students' knowledge curve as the two dimensional function of student and knowledge. Thus we get the line graph. However in the second graph the third dimension technology is added. This changes the whole scenario of the graph. It becomes a three dimensional graph which enhances the whole teaching learning experience.

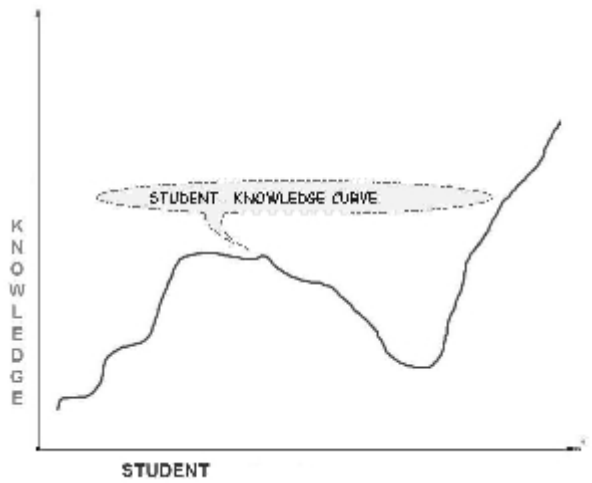


Figure 1

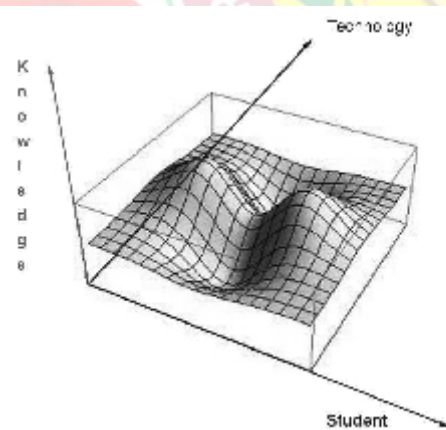


Figure 2

To integrate technology with mathematics education the following points should be taken care of:

1. Proper selection of the tool as per the content

2. Complete information and training about the technological tool.
3. Proper planning for the use of the tool
4. Testing the tool's effectiveness before implementing
5. Preparation of backup plan or Plan B
6. Evaluation procedures for the technological tool.

Developing Technology enhanced instructional material

- Hands-on: Students are actually allowed to perform science to construct meaning and acquire understanding. It takes these subjects out of the realm of the magical or extraordinary.
- Minds-on: Activities focus on core concepts, allowing students to develop higher-order thinking processes and skills, and encouraging them to question and seek answers that enhance their knowledge, and thereby acquire an understanding of the physical universe in which they live.
- Reality-on: Students are presented with problem-solving activities that incorporate authentic, real-life questions and issues in a form that encourages drawing on multidisciplinary knowledge, collaborative effort, dialogue with informed expert sources, and generalization to broader ideas and application.

The objective is to promote students' insight into the real scientific, technological, business and every-day world, and the skills needed to live and work effectively. Technology is important in both teaching and learning computational mathematics as it can not only influence the mathematics that is taught but also helps to enhance student learning. The word "enhances" is what characterizes technology as a tool with high leveraging power because technology can enhance a learning task..

Contrary to popular belief that mathematics is nothing but a mind game a lot of mathematical conjectures and results were a consequence of serious mathematical doodling. Today we have enough tools to experiment with mathematical concepts.

These include Dynamic Geometry Software (DGS), graphics calculators, spreadsheets and Computer Algebra Systems (CAS).

In particular, we observe the following areas where technological tools have become indispensable and have assisted us greatly in teaching, learning and research.

1. The capability of performing graphic, algebraic, numeric and symbolic representations within a CAS helps us not only for making educational conjectures but also verifying theoretical proofs.
2. The capability of constructing multiple 2D or 3D ...figures within a 2D or 3D DGS allows us conjecture if our 2D observations can be extended to ones in 3D. Some 2D or 3D scenarios provide us crucial conjectures before theories can be formed and verified using a CAS.
3. Once learners understand fully how a 3D scenario works with the help from CAS and DGS, they can generalize the theories to ...finite dimensions or beyond

There is a pool of softwares in the market which helps to make mathematics teaching effective. some of them as as follows: PISA, TIMSS, Geometers sketchpad, Mathematica, Cabri s 3D, Math disk, Flash earth, Autograph, Maple, Tablet academy, flipping classroom, hot math, calculator, excel. All these software enhances the teaching learning process.

Geogebra

Dynamic Mathematics Software -GeoGebra is an open source, accessible to everyone and easy to use. GeoGebra want to make teaching and learning easier and more fun for students. GeoGebra is free and multi-platform dynamic mathematics software for all levels of education that joins geometry, algebra, tables, graphing, statistics and calculus in one easy-to-use package. It has received several educational software awards in Europe and the USA.

Some Geogebra Facts

- Graphics, algebra and tables are connected and fully dynamic
- Easy-to-use interface, yet many powerful features
- Authoring tool to create interactive learning materials as web pages
- Available in many languages for our millions of users around the world

- Free and open source software

Challenges in using Geogebra

An important issue in teaching mathematics with GeoGebra was how the developing countries can get access to it and benefit from this software. In countries like India educational software technologies seem still out of reach due to internet access problems in schools and the high cost of most educational softwares. Since GeoGebra can be downloaded for free on a single laptop, then uploaded to many computers, and can be run without any internet access, it creates a favourable learning environment.

Other than Internet access, another critical factor is the IT knowledge of teachers working in a digital environment. A “higher aim” set in the Indian National Curriculum Framework now is to develop the children’s inner resources to think and reason mathematically, to be able to come to logical conclusions and handle abstraction. This requires teachers to fundamentally change their teaching methods. That is also why professional development related to GeoGebra is not only about learning how to enter a digital environment, but also about discovering its new, pedagogical potential in everyday teaching.

Other than one-time workshops, regular follow-up activities and an easy-to-reach mentoring system are necessary, too, so that teachers feel more confident about the use of the software in their classes. GeoGebra Institutes in India provide high quality, children focused trainings and support teachers while overcoming these problems. Teachers acquainted with the use of the software and discuss how to integrate it into everyday teaching. focused his training on the possibility of using GeoGebra in child-centered learning, highlighting the pedagogical aspects of the software rather than technical ones.

Use of Geogebra Software

Introducing GeoGebra into mathematics instruction is not an easy task for teachers, but it’s appropriate usage improves the instruction quality and helps students achieve better results in learning mathematics. The amount and the quality of the knowledge incorporated into students’ cognitive structure depends on the way the subject is represented to students and the ways the teacher, students, the subject material and the applets are interrelated in the

instruction process. This way of learning requires students to take active part in it which leads to acquisition of knowledge that is of higher quality and lasts longer.

One advantage of working in DIMLE is that students can learn mathematics through explorations, and solve problems in multiple ways. Thus Geogebra has given them a chance to build their own mathematical constructions depending their exploration and curiosity. Carrying out that exploration and taking the advantages depend on the realizing key qualifications of Geogebra. Typical Geogebra contains interactivity and dynamism as the key features. Interactivity means a fast feedback mechanism, which contains action and reaction iteration. Dynamism is related to continual change in the process. Both features are important to support learning process and to teach fundamental dynamic mathematical concepts by using technology. Geogebra provides a contact between multiple representations and mathematical abstract concepts. Thus it causes to develop the students' visualizing skills and to increase conceptual understanding;

Implications of technological tools

Because of these tools, the emphasis in the mathematics classroom has shifted from memorising procedures and techniques to conjecturing, meaningful problem solving and developing mathematical reasoning. These technologies provide numerous advantages. They enable the student to explore mathematical ideas graphically, symbolically and numerically. They can be used as pedagogical tools to extend student's mathematical thinking and provide possibilities in mathematical modelling activities. Their ability to effectively take over tedious calculations and algorithmic procedures reduces cognitive load on the student and enables her to focus on developing mathematical insight.

Conclusion

There should be dynamics into mathematics classes and easy understanding of the subject material. New technology introduced into the classroom in this way is not just a sheer replacement of the blackboard/chalk. It offers students an active exploration of the subject material and a possibility to bring conclusions independently. The role of teacher is to direct and monitor students' work. Mathematical concepts and procedures learnt in this way are

longer lasting and better incorporated into students' cognitive structure which makes them easier to apply. Such an instruction does not work in one direction only. Here, students are not only passive recipients of information meant to be remembered but active explorers and creators. We built gradually a Dynamic and Interactive Mathematics Learning Environment. This means that a mere introduction of new technologies into the classroom is not sufficient to achieve better results.

Still, we identified a significant danger that can be easily overseen while using digital technologies in mathematics instruction. Namely, all the efforts described here can be futile if one neglects symbolic approach to mathematics instruction. For this reason, we should insist on usage of educational software that allows a symbolic approach to mathematics as well as precise and fast calculations and dynamic sketches.

As the main issue, students must develop competence to decide when and how it is appropriate to use available ICT tools and to use them. These new requests put demands on those teachers who have not developed corresponding competencies themselves. Various designs should be made to integrate technology with mathematics. The design of these sessions does not see mastering the software as an end but as a means for the teacher to reach his teaching goals. The Principles and Standards for School Mathematics recommends that technology is an "essential tool for teaching, learning, and doing mathematics" (NCTM, 2000, p. 24). Geogebra was developed for supporting the learning mathematics through free exploration in the less constrained environments. Even though GeoGebra can influence what is taught, teachers need to design the suitable instructions and environment that best support this approach. Well-applied GeoGebra can support requirements of learning outcomes as it helps the children process mathematical concepts through investigation and problem solving. Thus Geogebra can act as one of the most important tool in the hands of the teacher for teaching learning of mathematics thereby acquiring the ultimate goal of education i.e., all round development of the individual!

By tapping into these powerful technology tools in mathematics, we can take advantage of the dynamic capability to graph, model, compute, visualize, simulate, and manipulate, and amplify the mathematical properties and concepts. This instructional technology focus has important implications in preparing teachers and students to teach and learn with technology.

Thus now the time has come where we need to transform mathematics education with the help of technology . Technology can aid in the visualization of concepts, in exploration and discovery, in bringing the experimental approach into mathematics, in focusing on applications, in redefining the role of the teacher, sustain students' interest, in individualized grading and assessment. But while technology has profound implications for teaching and learning, it does not supply solutions by itself. Problems faced in the class cannot be solved by mere introduction of technology. Thus serious research and experimentation is essential to use technology in mathematics education.

Lot of work needs to be done in order to integrate technology in mathematics education. perhaps the area of greatest challenge is teacher preparation, developing sustainable professional development programmes for teachers which will not only enhance the skills of the teacher in terms of usage of various technological tools but also focus on improving their pedagogical content knowledge using technology. The goals of mathematics learning and assessment need to undergo a major paradigm shift in a technology integrated mathematics curriculum. Also technology must be cost effective and easy to deploy in order to achieve large scale integration in schools and teacher educational institutions which has a tremendous implication in terms of infrastructural requirements. A proper attitude and mindset needs to be prepared in order to reap the benefits of integration of technology . So a deal of work remains to be done , but the benefits would clearly be enormous.

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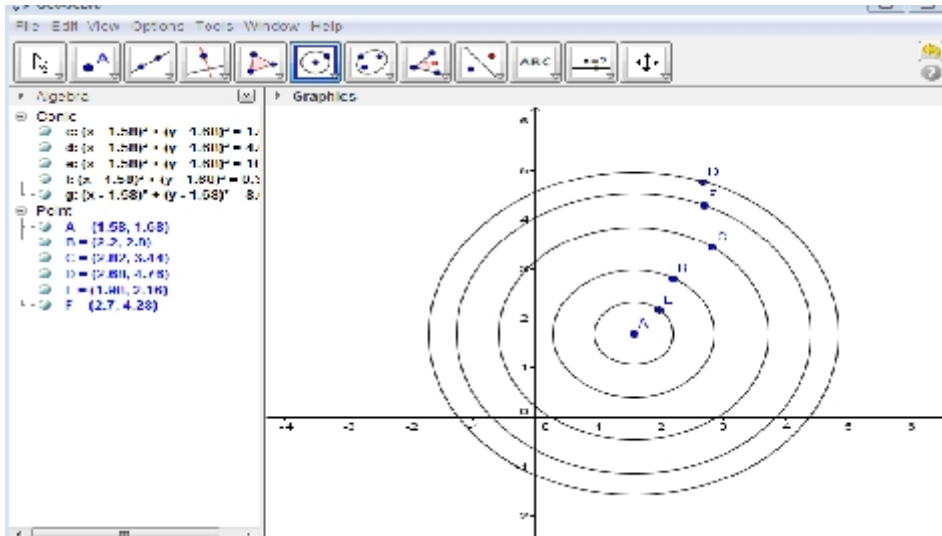
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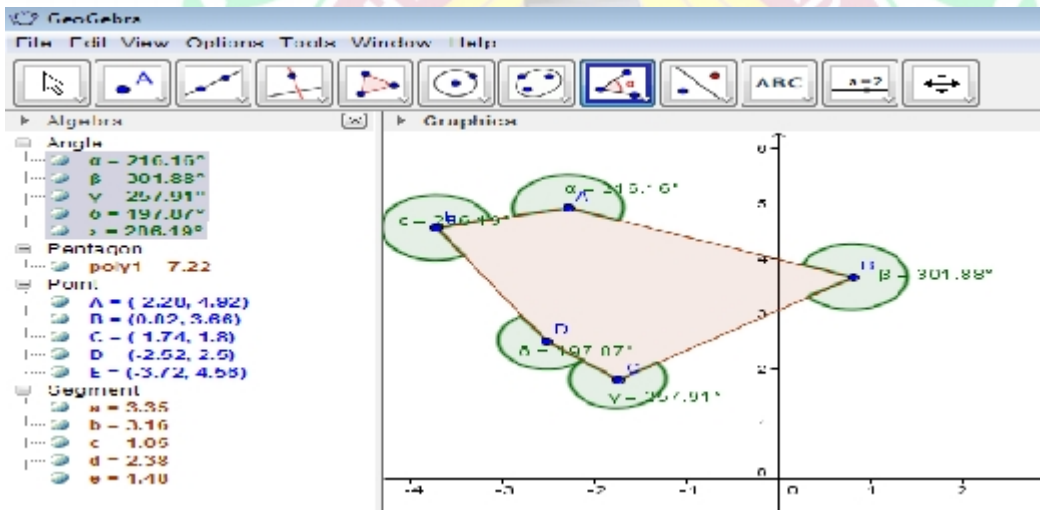
Websites

1. www.geogebra.org/
2. <http://www.rresearchinformation.co.uk/time.php>
3. <http://www.tojet.net>
4. [http://pkchaurasia.iitiancollege.info.](http://pkchaurasia.iitiancollege.info)
5. [www.eric.ed.gov.](http://www.eric.ed.gov)

Concentric circles with Geogebra



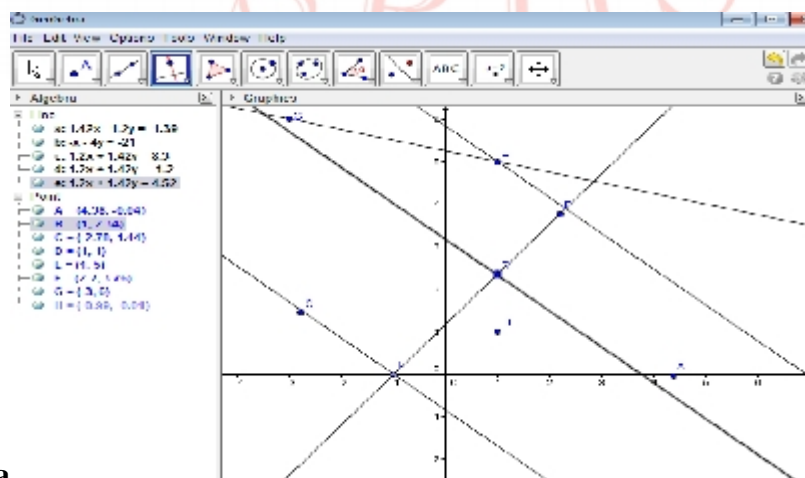
Polygon with Geogebra



Intersecting

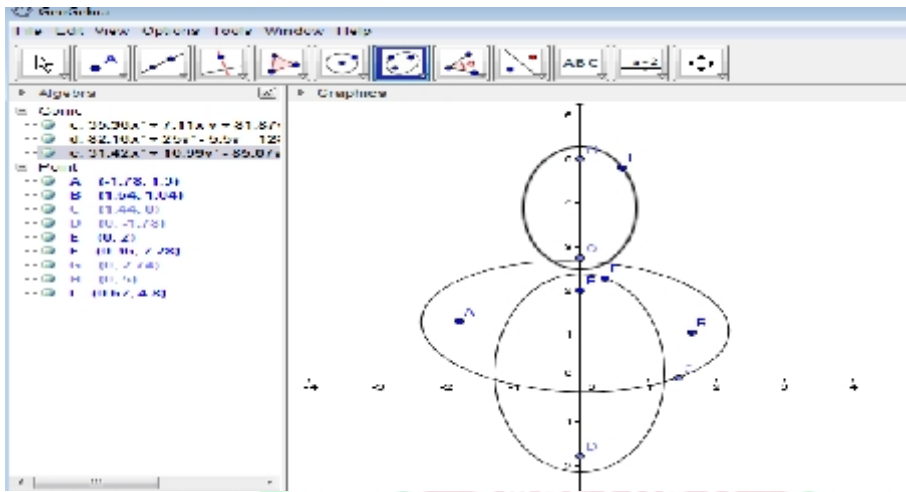
lines

with

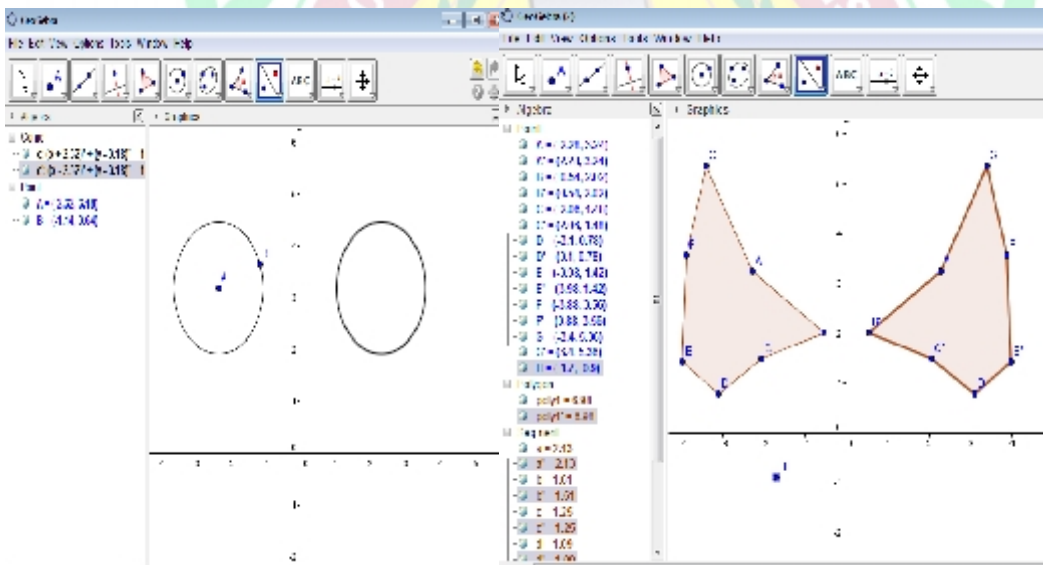


Geogebra

Ellipse With Geogebra



Mirror images with Geogebra



NPC with Geogebra

