Nitin Talokar

Using GeoGebra as a tool for better understanding of geometrical shapes and concepts

Context

Chhattisgarh, located in central India is the tenth largest state in India with a population of 25.54 million people. The northern and southern parts of the state are hilly, while the central part is a fertile plain. At the time of writing this article, Chhattisgarh had 16 DIETs, 2 BTIs (Basic Training Institutes), 1 CTE (College of Teacher Education), and 1 IASE (Institute of Advanced Studies in Education).

Surveys conducted by various institutes such as National Achievement Survey, State Achievement survey, Pratham, show that the understanding of mathematics in Chhattisgarh school children is very poor. Traditionally mathematics is considered as a difficult subject both by the teachers and students and geometry is no exception.

Geometry and ICT

"Geometry is the beginning of Mathematics for the young child since geometry is none other than the study of spatial relationships. It is the means of viewing a situation mathematically to provide one or more ways of gaining understanding. Almost every object has some geometric property, and stimulated by his experiences, a young child has an innate curiosity about geometry. Shapes, size and position are entities for him to explore, manipulate and control, and the means whereby he organizes his environment, so that geometry becomes the natural way for developing intuition, creativity, enquiry, and the ability to solve problems." Earnest Choat

Teaching of geometry can be made easier and more interesting using technology.Hundreds of figures may be drawn in minutes whereasdrawing byhand may be very difficult and time consuming. A teacher who is conversant with using ICT might find it possible to develop better pedagogy for teaching Geometry even in pen pencil method.In any case, given current developments in the world, it is imperative that teachers become conversant and comfortable with using ICT.

Capacity building in the use of ICT for teacher-educators is required. A separate provision has been made in the revised CSS for setting up of computer labs and purchase of equipment (CSS Guidelines 2012, Page 54).

It has been proposed in recent policies that technology in Teacher Education should be actively integrated in all teacher education institutions (TEIs). Satellite transmission communication, content development, MIS,interactive and self-paced learning should be the focus areas for bridging the divide digitally (Teacher Education Planning Handbook, 2014-2015, Page 4). It is suggested that the TEIs should have Resource Centre/ Teacher Learning Center and MaterialDevelopment.

"Use of resource center and educational technologies needs to beintegrated within the curriculum at all levels.Instead of providing a separate course onteaching applications for editing texts or spreadsheets,students could beexposed to pedagogical applications like Geo-Gebra (Mathematics) andMarble (Geography). ……..Appropriate training needs to be provided to the faculty in useof such applicationsbefore they can be integrated into the curriculum. …….DIETs can contribute to building a cadre of teachers with computer competence throughorganizing regularworkshops on Educational Technology".(Centrally Sponsored Scheme ofTeacherEducation, 2012 page 36).

What can be done?

In this article, I want to address an important area of mathematics i.e. Geometry at Upper

Primary Level. Specifically, I wish to examine the use of GeoGebra (an open resource software) with the DIET teacher trainee students to clarify their concepts and develop better pedagogy to teach geometry at elementary level. This will help them to visualize geometry shapes with little effort using technology. It will increase their knowledge of geometry and pedagogy of geometry to apply to their teaching in elementary schools.

GeoGebra is an interactive geometry, algebra, statistics and calculus application,intended for learning and teaching mathematics and science from primary school to university level. GeoGebra is available on multiple platforms with its desktop applications for Windows, Mac OS and Linux, with its tablet apps for Android, iPad and Windows, and with its web application based on HTML5 technology. Open-source developers and translators all over the world were part of developing this software. It makes math tangible but it doesn't replace teachers.

All 16 DIETs in Chhattisgarh are located in District Headquarters. Selection process of pre-service teachers is on the basis of an entrance test examination. In the selection process 80% seats are for Chhattisgarh native students and 20% seats are for all India students. This creates a rich diversity among the students. All teacher education institutes have good internet connectivity. Good internet connectivity through internet café is also available throughout the state. Pre-service teachers can use these facilities for reading study materials and updating their knowledge. Use of android cell phones with data connectivity is also very common among pre-service students and I plan to utilize this as well.All of my work will be disseminated for other students and teachers using SCERT website.

Objectives of my work are as follows:

i. To develop study material for systematic approach to teach GeoGebra based on our class 8th (Grade-8) textbook.

ii. To develop user manual for using GeoGebra based on our class 8th (Grade-8) textbook.

iii. To conduct ICT training for GeoGebra on developed user manual for 03 DIETs, 02 Private D.Ed. Colleges.

iv. Pre-Service students will be asked to develop their lesson plan using GeoGebra.

v. To enhance the visualization and understanding of Geometry shapes among pre-service students.

Educational Reform

In my reform proposal, I along with my State Resource Group, will develop study material for geometry taught at Grade-8 in our state. For this, workshops will be conducted at state level. After developing the study material with the help of our IT team at SCERT it will be converted to Geogebra open source software. In between training on Geogebra will be conducted for 03 DIET and 02 Private D.Ed. College. The study on pedagogy used to teach geometry by previous year pre-service students will be done. Pre-test on the content knowledge and visualization of geometric images will be done on pre-service students.

Trainings on Geogebra will be done at the DIET and in private D.Ed. Colleges. After training on Geogebra, post-test of pre-service students will be conducted. In the post-test content knowledge and visualization of geometric images will be tested. Revised lesson plan will be designed after discussion with pre-service students. We will design the better pedagogy to teach mathematics. Pre-service students will use revised lesson plan based on their understanding and visualization.

NCF 2005 talks about ICT and its potential in great detail but also cautions:

"While several countries have implemented CS and/or IT curricula in schools, we need to be aware of the challenges that Indian school students face. The first of these is the paucity of technology resources for computer science. It is absurd to teach computer science (let alone computer usage) without access to computing resources. Providing computer access and connectivity for all children is a tremendous technological and economic challenge. However, given the pervasive impact of computer technologies, we need to address this infrastructure challenge seriously and explore viable and innovative alternatives with regard to hardware, software and connectivity technologies appropriate for rural and urban Indian schools.

We also need to address the issue of the development of a comprehensive and coherent curriculum model in computer science and IT, which can serve as the basis for the beginning of a discussion between educators, administrators, and the general public. Certain core elements are common to several CS and IT curricula, and are applicable to Indian schools as well. These include the concepts of iterative processes and algorithms, general problem-solving strategies arising from computing, possibilities of computer usage, the place occupied by computers in the modern world, and the societal issues that arise thereby". (NCF 2005 Page 45-46)

As per Govt. of India Guideline digital resource repositories will be made available with contextual comment. "*Existing digital resource repositories from governments and NGOs including audio resources (EDC), video resources, animation movies etc. should be made widely accessible. It is important to make the resources available in districtrepositories linked to state repository. Student-teachers also need to learn how toaccess the World Wide Web for resources, including principles governing quality, authenticity of resources, rules of fair use etc.*"

(CSS Guideline page 81.)

Potential Barriers

Before implementing my proposal, I have identified some possible roadblocks and possible solutions:

- Will the Educational Institute respond for the implementation of Geogebra Software?: It will require educating the educational institute so that they will feel that it is useful for students to work on this and it will enhance the result.
- Student may be reluctant to respond the reform project: Students will be educated by their teacher educator about the importance and usefulness of the GeoGebra software. We will provide them hands on using GeoGebra software. It will be explained that they will enhance their quality of work and will increase if the GeoGebra is used.
- Technology expertise and availability of technology access may be a concern: The cost of using technology at cyber café in Chhattisgarh is relatively cheap. If student teachers are properly motivated then personal and institutional access can be provided.

Key Partners

The proposal cannot be implemented by one person sitting in the SCERT and requires cooperation between several partners including:

i. Diploma in Education (Distance Learning Mode) state level mathematics team at SCERT C.G.

ii. 03 DIET, 02 Private D.Ed. Colleges, Mathematics Faculty Members, Pre-Service students and administrators.

iii. State Resource Group (Mathematics). The state Resource Group will provide guidance for developing study material.

For further extending the reform project after one year, we expect the District Resource Group to co-ordinate along with:

iv. Mathematics excellence center established by ICICIFIG(ICICI Foundation for Inclusive Growth) at DIET Ambikapur.

Colleges will participate in the first phase where the faculty members will assist in content generation. The cooperation of the administrators of the respective institutes is vital. The team of mathematics teachers of Diploma in Education (Open Distance Learning Mode) will also help.

To assess the effectiveness of my reform proposal I will primarily rely on reports of the pre-test and post-test of pre service students. The possibility of online pre-test and post-test may also be considered.The student teachers of 03 DIETs, and 02 private D.Ed. will be involved. There are 100 students per DIET, 50 students each in private D.Ed. colleges. As this is an innovative style of project to be implemented in Chhattisgarh, the instrument has to be designed after the consultation of student teachers and faculty membersso that a realistic instrument can be designed.Reports related to content enhancement and pedagogic development will be analyzed. The effectiveness of study material developed and user manual developed will be analyzed. Based

on the feedback of student teachers and faculty members it will be modified to improve its quality. After success in first year it will be applied to all DIETs and private D.Ed. Colleges.

The evaluation of my reform project will be done in following ways:

i. Developed study material will be evaluated by State Resource Group.

ii. Developed user manual for using GeoGebra will be evaluated by IT team Members of SCERT, DIET and ICICIIFIG.

iii. Interviews of pre-service students and teacher educators will be done after ICT training.

iv. Interview of lesson plan supervisor will be conducted for the comparison of the lesson plan prepared last year and after the GeoGebra is introduced.

Conclusion

As described in the article, during my three month program in Arizona State University, I prepared a reform proposal for working on conceptual clarity of geometrical topics among D.Ed. students using geogebra software. The reform proposal has been submitted in our department. They have scrutinized the reform proposal and suggested some changes.The suggestions were made by the Secretary, School Education, Government of Chhattisgarh who felt some schools should be included.

The state resource group members have been identified. The 10 member SRG was formed in June, 2015 and included faculty from the SCERT, subject experts from IFIG Raipur as well as teachers and lecturers from government schools. It was felt that the Geogebra software must be promoted primarily in the RMSA schools where ICT@School program is running and 10 computers per school are available. It is decided that the SRG group will meet once every three month and will be in contact using whatsapp group and e-mail. Study materials are being developed by individuals and will be collated. Initially we were following the basic Geogebra Manual and 63 Videos available on Geogebra Tube/ You Tube Chanel based on the basic Geogebra Manual. Videoswere downloaded and distributed to SRG. Translation of this manual in Hindi and mapping of topics with our text books is in progess.

I have identified 04 schools including Teacher Training Institutes. The development of user manual and some study material on GeoGebra is ongoing but progress is slow. I visited three schools and have installed Geogebra, discussed with teachers and shared 63 Videos (930MB, MP3 Format). The best part of the video is that it can be played directly through USB Drive available in schools T.V. Set. I also installed PhET Simulation for Maths, Physics, Bio and Chemistry.

During the school visits and on inspecting the computer rooms and in discussions with the students I found that the computer lab is used for teaching word, excel and powerpoint. This leaves both the students and teachers dissatisfied as they realize the potential of computers but are ill-equipped to utilize them. They requested simulation softwares, teaching material and material related to their textbooks which could be used in off-line mode. This is because the internet is not available everywhere and the speed is very slow even where it is available.

The main challenges are time given to school by me. Schools are open at 10:30 am and closes at 4:30 pm. Beyond the school hours it is very difficult to work with them.From SCERT, frequently visiting school is also very difficult because of the work load.School principals think that it is an additional ICT activity so they are reluctant to provide their own subject period for GeoGebra. They think that it is a computer class and must be conducted beyond their subject periods. I think it is subject matter and should be taught with their text book. To overcome this problem, I am planning to map it with text book, translate in Hindi and implement in all schools of ICT@School. While there are many challenges, I hope to successfully implement my project.

References

National Curriculum Framework, 2005. NCERT INDIA.

National Curriculum Framework for Teacher Education, 2009. NCTE INDIA.

Restructuring and Reorganization of the Centrally Sponsored Scheme on Teacher Education, Guidelines for Implementation, June, 2012 MHRD INDIA.

Justice Verma Committee Teacher Education Report.

Bu, L. (2010). Modeling the mirascope using dynamic technology. MAA Loci. Retrieved from http://mathdl.maa.org/mathDL/23/?pa=content&sa=viewDocument& node Id=3595.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., &Schauble, L. (2003). Design experiments in educational research. Educational Researcher, 32(1), 9–13.

Freudenthal, H. (1973). Mathematics as an educational task. Dordrecht, Holland: D. Reidel Publishing.

Hohenwarter, M., &Preiner, J. (2007). Dynamic mathematics with GeoGebra. Journal of Online Mathematics and Its Applications.

Johnson-Laird, P. N. (1983). Mental models: Toward a cognitive science of language, inference, and consciousness. Cambridge, MA: Harvard University Press.

Lesh, R., &Doerr, H. M. (Eds.). (2003). Beyond constructivism: Models and modeling perspectives on mathematics problem solving, learning, and teaching. Mahwah, NJ: Lawrence Erlbaum.

Lesh, R., Hamilton, E., & Kaput, J. (Eds.). (2007). Foundations for the future in mathematics education.

Merrill, M. D. (2002). First principles of instruction. Educational Technology Research and Development 50(3), 43–59.

Milrad, M., Spector, J. M., &Davidsen, P. I. (2003). Model facilitated learning. In S. Naidu (Ed.), Learning and teaching with technology: Principles and practices (pp. 13–27).

Mooney, D. D., & Swift, R. J. (1999). A course in mathematical modeling. Washington DC: Mathemaitcal Association of America.

Pollak, H. O. (2003). A history of the teaching of modeling. In G. M. A. Stanic& J. Kilpatrick (Eds.), A history of school mathematics (Vol. 1, pp. 647–671). Reston, VA: National Council of Teachers of Mathematics.

Presmeg, N. (2006). Semiotics and the "Connections" standard: Significance of semiotics for teachers of mathematics. Educational Studies in Mathematics, 61, 163–182.

Seel, N. M. (2003). Model-centered learning and instruction. Technology, Instruction, Cognition and Learning, 1, 59–85.

Shulman, L. S. (2002). Making differences: A table of learning. Change, 34(6), 36–44.

Spector, J. M. (2000). Introduction. In J. M. Spector & T. M. Anderson (Eds.), Integrated and holistic perspectives on learning, instruction and technology: Understanding complexity (pp. xi–xxii).

N. M. Seel& S. Dijkstra (Eds.), Curriculum, plans, and processes in instructional design: International perspectives (pp. 271–287). Mahwah, NJ: Lawrence Erlbaum.

Streefland, L. (Ed.). (1991). Fractions in Realistic Mathematics Education: A paradigm of developmental research. Dordrecht, Netherlands: Kluwer.

Treffers, A. (1987). Three dimensions: A model of goal and theory description in mathematics instruction—The Wiskobas Project. Dordrecht, Netherlands: D. Reidel.

Van den Heuvel-Panhuizen, M. (2003). The didactical use of models in realistic mathematics education: An example from a longitudinal trajectory on percentage. Educational Studies in Mathematics, 54, 9–35.

Van Merriënboer, J. J. G., Clark, R. E., & de Crook, M. B. M. (2002). Blueprints for complex learning: The 4C/ID-model. Educational Technology Research and Development, 50(2), 39–64.

Van Merriënboer, J. J. G., &Kirschner, P. A. (2007). Ten steps to complex learning: A systematic approach to four-component instructional design. Mahwah, NJ: Lawrence Erlbaum.

Zbiek, R., & Conner, A. (2006). Beyond motivation: Exploring mathematical modeling as a context for deepening students' understandings of curricular mathematics. Educational Studies in Mathematics,63, 89–112.